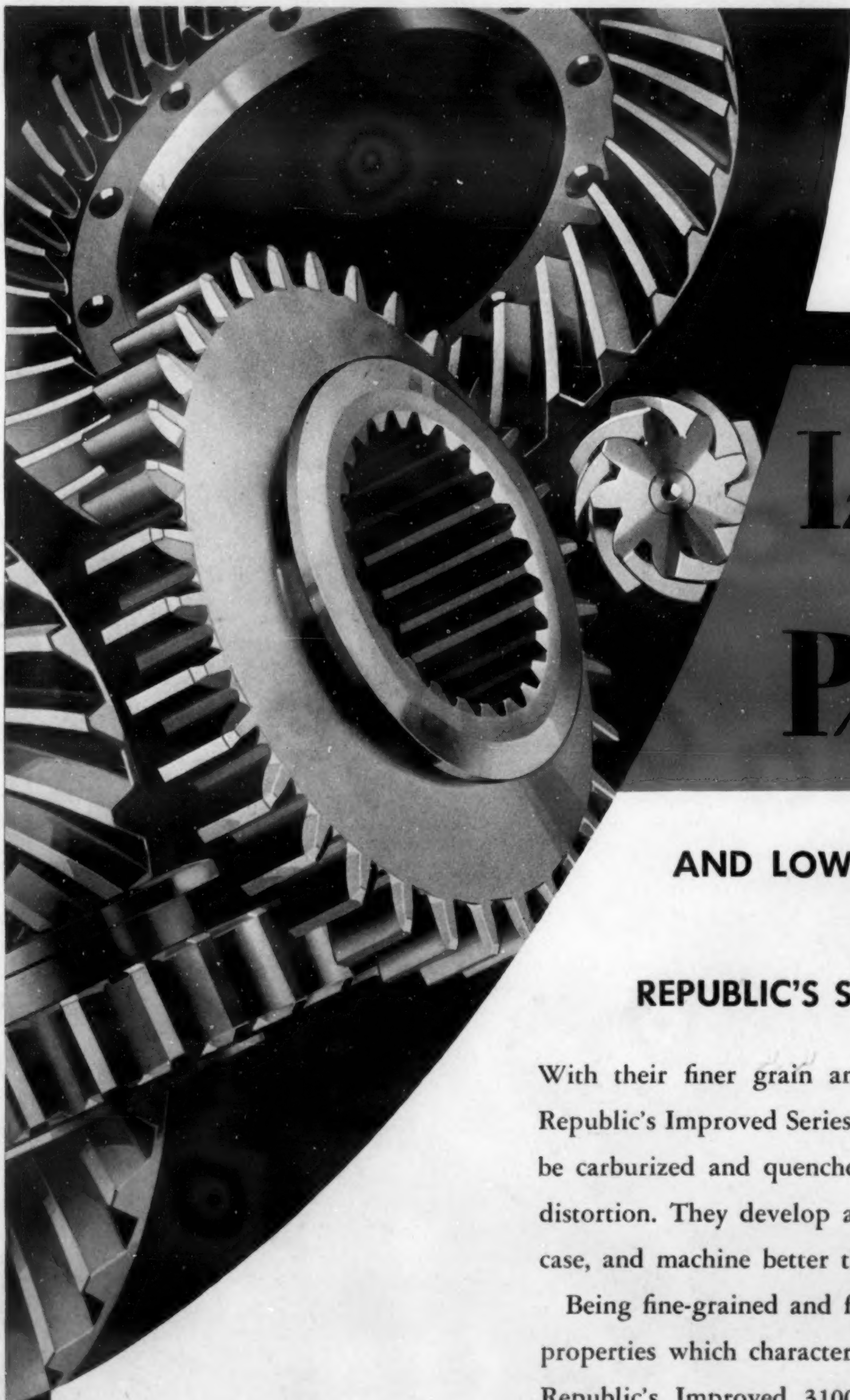
AUGUST, 1934

METALS & ALLOYS

The Magazine of Metallurgical Engineering

PRODUCTION · FABRICATION · TREATMENT · APPLICATION

Current Metallurgical Abstracts



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METALS & ALLOYS

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Production • Fabrication • Treatment • Application

PUBLICATION OFFICE:
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Battelle Memorial Institute,
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CURRENT METALLURGICAL ABSTRACTS

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Entered as second-class matter June 12, 1934, at the post office at East Stroudsburg, Pa., under the Act of March 3, 1879.

Typical pressure castings of Anaconda Brass

HIGHLIGHTS

by H. W. GILLETT

Gas in Cast Iron

Gas evolved in the freezing of cast iron is largely hydrogen, according to Quincy (page MA 386 L 6) who examined the gas trapped in the shrinkage cavity of a centrifugal casting.

Acid Open Hearth Slags

Acid open hearth operators will be interested in the discussion of acid slags by Koerber and Oelsen (page MA 385 L 5) who think that silicates of iron and manganese as inclusions are dissociated in the melt and supply free silica to the slag.

A Dose of Carb.

According to Evans (page MA 385 L 1) sodium carbonate is good for what ails cast iron as well as for human indigestion, curing shrinkage cavities, gas holes, reducing S and improving machineability. Anyhow, he calls it by its chemical name instead of some patent medicine term.

Slag Contact Helps High Carbon Cast Iron

Bardenheuer and Reinhardt (page MA 385 L 3) find that low carbon cast irons are injured and high carbon ones helped by contact with slags low in iron oxide.

Alterations Increase Cupola Output

Achenbach (page MA 385 L 8) finds that some German cupolas could easily be made to give larger outputs by slight alterations.

Rotating Powdered Coal Furnaces

Two Belgian articles (Goffart & Boussard and Frion, page MA 397 L 1-4) advocate rotating powdered coal furnaces for cast iron, especially for superheating and for high test iron.

What You See

According to Granjon (page MA 403 L 1) buckling that you can see in a weld isn't as bad as internal stress that you can't see.

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Diamond Tools

Taylor (page MA 391 L 2) and Schlippe (page MA 391 L 3) point out the advantages of diamonds as cutting tools. Taylor puts diamond raisins in a tungsten carbide pudding—a combination especially useful for dressing of abrasive wheels, while Schlippe advocates diamond tools for smooth finishes on non-ferrous alloys, such as bearings. The tool may burnish as well as cut.

Also, Avoid Barnyards

A few months ago one of the abstracts pointed out that buried pipe lines should avoid huckleberry swamps, which are corrosive to the pipe. Heltzel (page MA 420 L 1) now adds that they must avoid barnyards for the same reason.

Steel Houses Rampant

Seven papers abstracted in this issue (page MA 424 R 1) describe new steel houses.

Photoelastic Study of Impact

Photoelastic study of stresses, using polarized light and celluloid models has given useful information on how to avoid failures due to localized stress. Tuzi and Nisida (page MA 410 L 1) have extended the method of impact stresses, photographing with exposures of 1/50,000 sec., to catch the propagation of the wave of stress. For once, observation and theory as to intensity of stress agreed pretty closely.

Erichsen Test

Sachs (page MA 410 R 1) suggests the use of a conical plunger in the Erichsen test, as giving results more comparable with actual deep-drawing properties.

Paint and Corrosion Fatigue

Speller and McCorkle (page MA 420 R 1) find that a good paint helps steel resist corrosion fatigue.

Brine Corrosion

Steinbach (page MA 420 R 2) warns against evaluating metals for resisting corrosion in the brines used in ice plants by study of the behavior of a single alloy in the brine, for if some other metal is also in the brine the corrosive conditions may be entirely different. The combination of galvanized iron and bare iron together is bad, but, that of lead coated iron and bare iron stands up better.

Air Supply in Furnaces

Checks on the preheating of the air supply for blast furnaces, open hearths and air furnaces are mentioned as desirable by Schneider (page MA 386 L 2) while Rudolf (page MA 383 R 5) suggests the development of a "rate-of-heat" meter to give such information.

Jolting Ingots, Not So Hot

Herzog (page MA 386 L 1) reports on recent experiments on jolting of steel ingots at the Thyssen works in Germany. He concludes that the scheme, suggested every now and then since 1889, is not so hot.

Books

McMullan (page MA 382 R1) has written two little books on heat treatment of metals that form a good introduction for the beginner. The book (reviewed page MA 412 L1) on X-ray studies of the crystalline state, by the Braggs, is for the advanced specialist.

New Type Tube Mill

A new type of tube mill rolls the tubes over a mandrel and is said to produce tubes of superior quality (page MA 390 R1).

Carroll (page MA 392 R7) claims that in rock drills for mining, carbon steel has it over alloy steel.

Editorial Comment

Fundamentals

DESPITE ALL the details as to production methods, the finehaired control of properties, the wearisome matter of patent protection, the working out of methods of testing, the drawing of specifications and what not, that remain to be worked out as a new metallurgical product comes into service, and despite the research that is generally required to clarify the theories and allow commercial practice to be understandable and controllable, it is amazing how often two or three basic facts that can be expressed in a few words give rise to new products or important advances in old methods.

Once these fundamentals are firmly established, it takes only horse sense to put them together and build up a new branch of industry, if only the economic and political conditions are such that they fit commercially as well as technically.

Given the fact that steel rusts, that high chromium alloys do not, that the high chromium alloys are expensive, that chromium plating tends to be porous and that it does not give electrochemical protection, the development of undercoats of copper and nickel beneath chromium plating to overcome the effect of porosity, or as a further step, the development of duplex material with a steel back and a stainless surface are the inevitable results.

Complex organic molecules are adsorbed by an iron or steel surface, but very much less so by iron oxide. Acid can only attack iron or steel when it comes into contact with it. Hence, a suitable organic material in a pickling bath holds back attack on steel while permitting it on scale, and we have inhibitors.

Molybdenum prevents temper-brittleness in steel. Nickel-chromium steels are often temper-brittle. This, along with other facts that can be equally simply stated, leads to Ni-Cr-Mo steels. The 5% Cr steels resist corrosion and scaling in petroleum still-tube service, but have poor high temperature strength. Molybdenum steels have no particular corrosion or scaling resistance, but they have remarkable high temperature strength. Hence, the 5% Cr-½% Mo still-tube steel comes in in large tonnage.

Certain solvent dewaxing methods for lubricating oil must be carried out at —50° to —80° F. Steels vary in low temperature properties, some being very brittle, others tough. Once we have dependable information on the low temperature properties of the steels that could otherwise compete, the choice of a steel will be a simpler matter of horse sense, all we need are the fundamental facts.

Sometimes the fundamental facts need very precise determination because different materials add up about the same. In aircraft and in the new high speed trains, a high strength-weight ratio and good corrosion resistance are needed. Duralumin or Alclad duralumin and stainless steel meet these conditions, but vary in other properties whose effects can be pretty much equalized by mechanical design so that the choice is something of a toss-up. In the railway service, provided any such construction isn't too flimsy for safety in case of a serious collision, other high yield point steels of lower cost than stainless are likely to edge in because the corrosion problem is not as serious.

Aluminum bronze has fine properties, but is mean to cast, not only because of the oxide skin but also because of extreme piping. If one could avoid the piping and retain the strength and corrosion resistance, it would be a much better casting alloy. Since it forges easily, in many cases it is best to resort to forging instead of casting.

Molten copper in a hydrogen atmosphere is extraordinarily fluid and will run into capillary spaces. Steel surfaces can be kept clean at the melting point of copper, in hydrogen. Hence we have copper brazing in hydrogen, with its wide applications.

There is stress concentration at a notch or a sharp change in section. Hence design of parts to withstand repeated stress must avoid such stress-raisers or be very wasteful of material. A vast number of failures occur from disregard of this fundamental.

At earlier stages in metallurgical knowledge, these and many other similar fundamentals that could be cited were not clear cut, but were hazy and but little understood, or not so thoroughly corroborated by different observers as to have gained acceptance. Many others are still in the hazy stage.

When the research man talks about "fundamental research" he may have in mind either a delving into the mysteries of nature for yet undiscovered basic facts, or very detailed and extensive theoretical investigations into apparently obscure and complex phenomena, without any definite and useful application in mind. But when such investigations have been carried to the point where the underlying facts can be expressed in tabloid form without fear of contradiction, so the non-technical man can figure out just what they mean and use them in the horse sense addition of two and two, the high-brow stage is passed and the information becomes highly "practical."

Before proper utilization can be had, however, the facts must be generally accepted, not merely known to or understood by a few specialists. Reiteration of its value, advertising and sales promotion are generally required before any new thing can get, first financial backing for production, and second wide enough use to make its production profitable.

But those who are quickest to grasp the fundamentals and to utilize them before everyone else understands and utilizes them too, are the ones who reap the harvest.—H. W. Gillett

William Hastings Bassett

THE DEATH is announced of William H. Bassett on July 21 at his home in Cheshire, Connecticut. He had been ill for several weeks and confined to his home, but his death came suddenly and unexpectedly.

Thus passes one of the technical pioneers of the brass industry. When Mr. Bassett was first introduced to it in 1902, it was in the throes of an important transformation, emerging from the dominance of tradition handed down from father to son. Little respect or even attention was paid to the gifts which science even then had to offer it. To Mr. Bassett may be justly ascribed the credit for having introduced modern chemical and metallographic science into the brass mills, and of utilizing these newer scientific methods in those transformations which have subsequently occurred in the metallurgical art of the brass mills.

During the major portion of his professional life, he was associated with The American Brass Company, and the large volume of research and development work for which he and his associates were responsible was directed principally toward the simplification of mill practice and the improvement and standardization of mill products. For his achievements along these lines, he was awarded the James Douglas Medal in 1925 by the American Institute of Mining and Metallurgical Engineers. To the field of materials standardization in particular, Mr. Bassett devoted a great deal of attention, and to his continuous efforts and his constructive leadership in it, the non-ferrous metals industry owes much of the progress which has been made in the past thirty years along these lines. It is strangely fitting that this,—almost life work of his, should have brought him in the last year of his life the recognition of The American Society for Testing Materials, with which he was so long and so constructively associated, in the form of the Presidency.

Mr. Bassett has often been called the "dean" of non-ferrous metallurgists and that term justly reflects the prestige of his knowledge and experience in the industry which he served so long. It suggests in addition, however, particularly to those who knew him well, that warm and friendly side of him, which led him to devote generously of his time and energy to the interests of his associates and to those of the many technical societies of which he was a member. There were few matters of interest in his profession on which his counsel was not sought and usefully given,—few committees of importance to his industry on which he did not serve.

In this passing of an early leader and a sympathetic friend in the industry with which he was associated, something of the spirit of its transformation and of its growth during this century has gone from us forever.

William Hastings Bassett was born in New Bedford, Mass., in 1868, and was graduated in 1891 from the Massachusetts Institute of Technology. In 1903 he became Chief Chemist and Metallurgist of The American Brass Company and subsequently Technical Superintendent and Metallurgist, and since January 1, 1930, Metallurgical Manager. He was a Director and former President of the American Institute of Mining and Metallurgical Engineers, a member of the American Institute of Chemical Engineers and of the Society of Automotive Engineers, the Franklin Institute, Institute of Metals (Great Britain), and the Society of Chemical Industries. He was a thirty-second degree Mason and a member of the Knights Templar; his clubs included the Engineers' and Chemists' of New York.

Mr. Bassett's publications cover a wide and diverse field of his experience in non-ferrous metallurgy and including in particular articles dealing with the causes and prevention of corrosion cracking, articles dealing with the application of the spectroscope to the analysis of non-ferrous metals and articles dealing with the embrittlement of copper. Many of his articles have been published in the Transactions of the American Institute of Mining and Metallurgical Engineers.—PAUL D. MERICA.

DEATH HAS again taken a member of our Editorial Advisory Board, another of the "Elder Statesmen" of Metallurgy. Dr. Merica's comment appraises Mr. Bassett's great service to metallurgy, and we need not expand upon them. Large and varied as were his technical services to metallurgy, his personal influence made an equal mark. As was the case with the other member of the Editorial Advisory Board who has passed away, Mr. L. W. Spring, Mr. Bassett also had in marked degree the ability to view a controversial subject from a detached point of view and to be unaffected by matters of expediency.

What these men knew and what of their knowledge they passed on to their associates and through their publications will long continue to affect the upward progress of metallurgical science and technology. What they were and what they stood for as men has, in no less strong degree, affected many a situation that men of less integrity and broadmindedness would have dealt with in far different fashion.

The way of these men was ever the way of sound and lasting progress. We can ill spare them, but we are the better for having so long had their examples.—H. W. GILLETT.

BEARING METALS

of Lead Hardened with Alkali and Alkaline Earth Metals*

By Leland E. Grant †

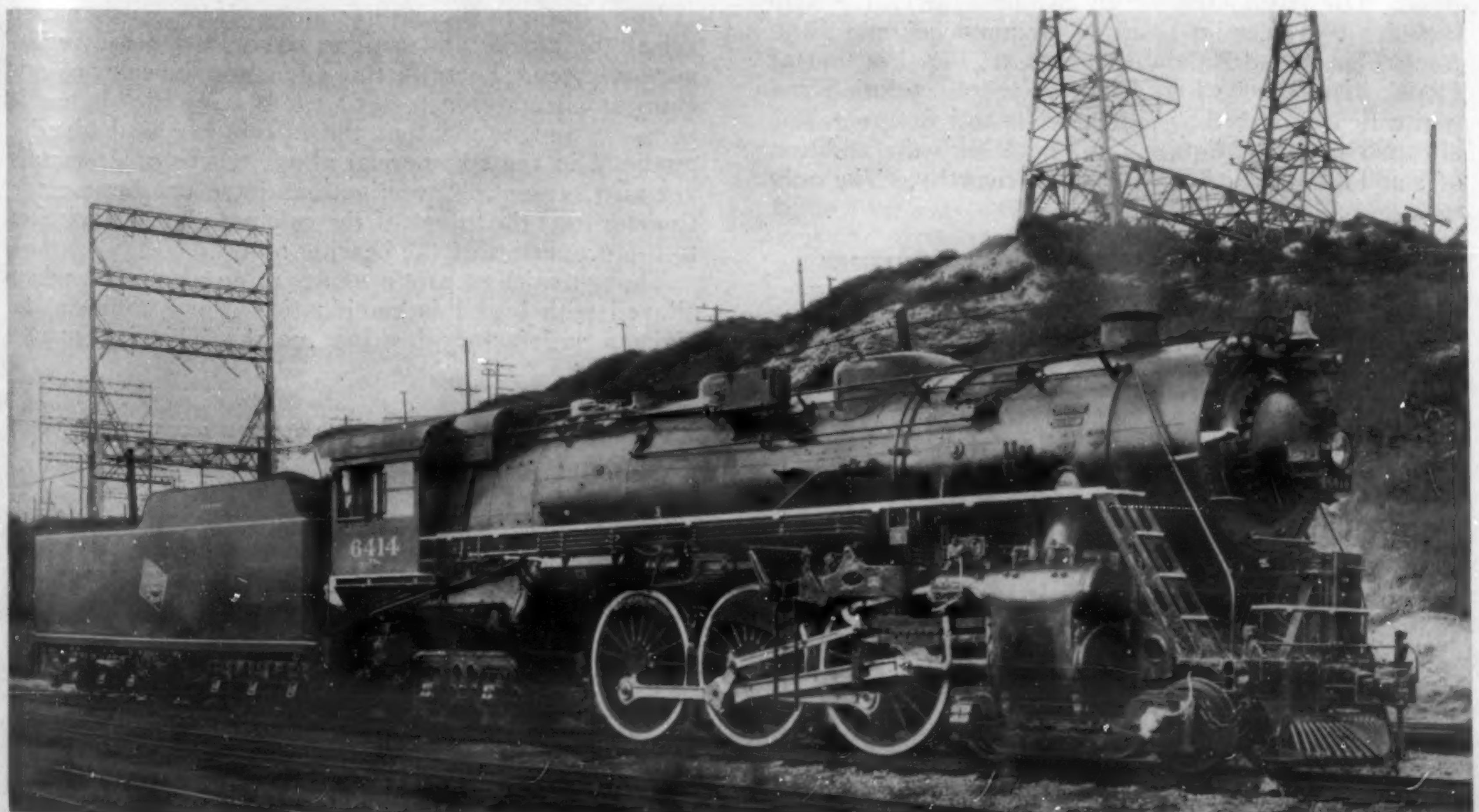
BEARING METALS which have lead as a base and are not hardened with tin and antimony are comparatively new. They have not as yet come into wide use although they appeared to have promising properties when first announced. More experience with the alloys in service developed certain characteristics that were not desirable in bearing metals and consequently they were not widely used. Later work resulted in the development of more satisfactory alloys which are now being used. In Germany the lead-alkali-alkaline earth bearing metals are used quite extensively, while in the United States the use of this type of bearing metal is increasing. It does not, however, appear likely that any of the present alloys will entirely displace either the cheaper lead-tin-antimony type or the standard tin-base babbits, but if further improvements can be made in the alkali-alkaline earth-hardened lead alloys they may become a more important factor in the field of soft bearing metals because they do have some excellent characteristics.

The fact that lead could be alloyed with calcium was known as far back as 1859 when Caron[1] investigated the lead-calcium system, but the possibility of using such metals for bearings apparently was not recognized at that time. It was not until early in the 20th century that a more systematic and comprehensive study of the system was made with the object of determining the constitutional diagram rather than for possible applications. Not until 1915 was the value of the profound hardening effect, produced by the alloying of calcium with lead, appreciated and efforts made to utilize it in the manufacture of commercially useful alloys. In that year Frary and his coworkers in America, and Hans and Walter Mathesius in Germany announced the discovery of the hardening effect of calcium on lead about the same time. Frary was seeking a substitute for antimony for use in hardening bullets. Both antimony and tin had become scarce and high in price owing to the limited imports of these metals following the beginning of the war. Since calcium was found to be an effective hardener, it was inevitable that the similar elements, barium and strontium, should also be tried as well as the closely related metal, magnesium. Previous to this time, little or nothing seems to have been done in the way of alloying these alkaline earth metals with lead.

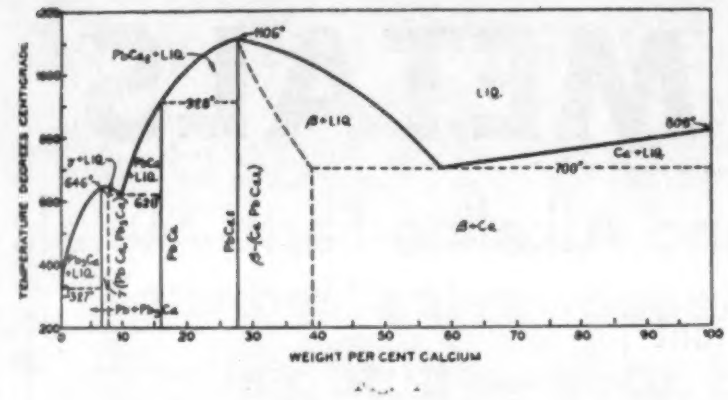
Lead-sodium alloys had been made and used for bearings before the advent of Frary metal and some information on the constitution of this system developed. The addition of lithium to lead did not come until later. Alloys of lead with the alkali metals, caseium and rubidium, do not appear to have been studied at

* A Correlated Abstract.

† Chief Chemist, Chicago, Milwaukee, St. Paul & Pacific Railroad Company.



Hudson Type Locomotive. This type engine used the Latco hub liner mentioned in this article.



all. They do not, of course, offer much promise for use in bearing metals because of their great chemical activity and high cost. Alloys of potassium and lead have been studied but they have not attained commercial importance. Some of the numerous patents for lead-alkali-alkaline earth bearing metals include potassium as one of the components.

In order to explain fully the reasons why the alkali-hardened lead alloys have not come into extensive use, and to emphasize the lack of basic information on the fundamentals of the entire subject, a short discussion of the various binaries is necessary. Scarcely anything has been done on the ternaries or more complex systems although all of the useful alloys belong in these groups. Here is a wide field for research and it appears that the increasing demands of industry for bearing metals that will function satisfactorily at higher temperatures and higher loads will stimulate the metallurgists to carry out such research. More serviceable alloys will undoubtedly be produced in the future as the result of the solution of some of the problems involved.

With the exception of the lead-calcium and lead-sodium systems, the information on the various binaries involved is scanty and incomplete. Further changes and corrections in all of the diagrams can be expected. The similarity in many of them is very evident. The latest diagram of the lead-calcium system includes the splendid work of Schumacher and Bouton.[4] Figs. 1 and 2 show this system; Fig. 1 is that of Donski[2] and Barr[3]; Fig. 2 shows the solid solution and peritectic discovered by Schumacher and Bouton. The abrupt rise of the liquidus in Fig. 1 with the addition of small amounts of calcium is noteworthy. The only compound of interest in connection with bearing metals is Pb_3Ca. This is the phase that produces the extensive changes in the properties of the lead and makes the alloy of use in bearings. Although calcium has a very low solubility in lead it is the precipitation of the compound that is the cause of the age hardening phenomena. Whether or not the compound itself exists in solid solution has not as yet been determined. The limit of solid solution at equilibrium is 0.10% calcium but in commercial alloys, which are generally chill cast, the amount held in solution will be greater. Also, in bearing alloys, the calcium content will be high enough so that in addition to the solid solution there will be crystals of the compound as a separate phase. These crystals are comparatively hard and of course contribute to the hardness and strength of the metal.

It is quite evident from what has been published on this system that the addition of calcium hardens lead very extensively but the specific hardness for any given concentration cannot be stated as no hardness surveys have been reported. Some hardness values were given by Schumacher and Bouton in their paper but these values are not in terms of any common hardness scale. They studied only very low percentages of calcium and required a sensitive scale to differentiate between various alloys. The writer tested some of their 0.04% Ca alloy, which they kindly made available to him, and found a Brinell hardness of 8 using a 10 mm. ball and 500 kg. load for one minute. The alloy had been cast in a metal mold and aged at room temperature for one month. Thieme[5] found an alloy, containing between 0.8 and 1.0% Ca. to have a hardness of 15. Fairly pure lead has a Brinell hardness of 4 so it is evident that the first addition of calcium is the more effective in hardening. Further hardening can be produced by quenching the low calcium alloys from above 280° C. and aging at room temperature (precipitation hardening) but this is not of any importance in bearing metals. Other hardness values that will be found in the literature are on alloys containing other elements besides calcium.

In addition to increasing the hardness, calcium also raises the tensile and fatigue strength and the resistance to creep.[6] These factors enter into the value of calcium as an addition to lead for bearing metals but it is to be understood that the effects are undoubtedly modified in the commercial alloys where other metals are also present. Investigations have not been made to determine the effect of the calcium alone in relation to the properties of the bearing alloys.

Though calcium produces desirable properties when alloyed with lead this combination is not sufficient to make a satisfactory bearing metal. This is because

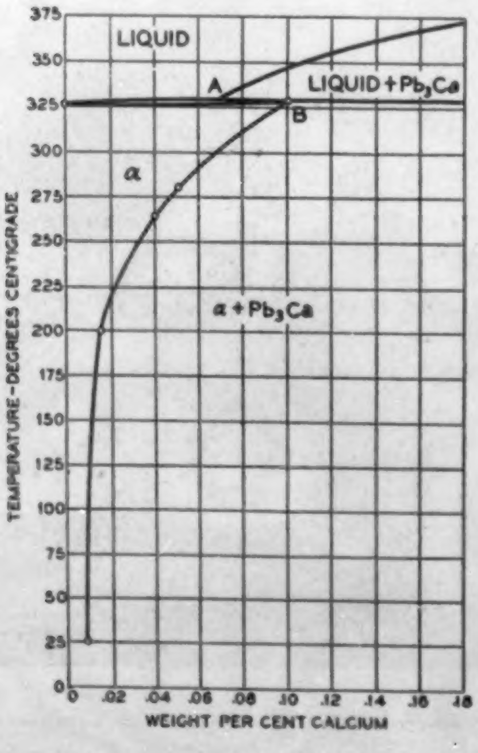
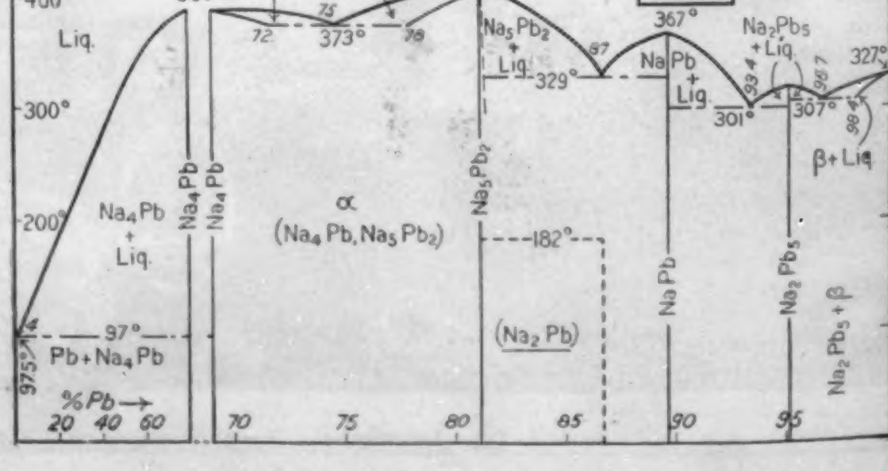


Fig. 2 (at left). From paper by Schumacher & Bouton.

Fig. 3 (at right). Lead-Sodium System. (From International Critical Tables, Vol. II. Courtesy McGraw-Hill Book Co., Inc., New York.)



the alloys are too soft when the calcium content is low. On the other hand if sufficient calcium is added to make the metal hard enough for a bearing there is trouble with excessive segregation. Segregation begins at around 1.5% Ca,[7] which is too low by itself to make a good bearing metal.

A satisfactory constitutional diagram for lead-barium has not yet been worked out. In fact the investigation of the system has not yet been carried beyond 15% Ba. Considerable difficulty has been encountered in the researches that have been made, owing to the spontaneous oxidation in air of lead-barium alloys containing somewhat more than 5% Ba. An alloy containing 14% Ba, disintegrated to a powder on exposure to the air. Obviously a system with such properties cannot be treated by the usual methods. Some data on alloys with relatively small amounts of barium are available although they are meager and there is some disagreement. Unlike calcium, the first addition of barium to lead causes a lowering of the melting point and this effect is continuous up to 4.5% barium which is an eutectic point. The temperature of the eutectic is given as 282° C. by Czochralski and Rassow,[8] but as 290° C. by Bochvar.[7] Cowan[9] and coworkers reported the eutectic at 291° C., agreeing with Bochvar. Since they found the eutectic in Frary metal to be at 284° C., 2 degrees higher than the lead-barium eutectic as given by Czochralski, it would appear that the higher temperature is the more probable one.

There is good evidence that a solid solution exists though the point has not been definitely proved. Cowan and coworkers found the eutectic existing down to 0.5% Ba. while Czochralski reported it as being present in alloys containing as little as 0.4% Ba. Lead-barium alloys exhibit age hardening, and small amounts of calcium and barium together produce greater hardness than an equal quantity of either one alone. In the development of Frary metal homogeneous grains, surrounded by eutectic, were found in alloys containing up to 0.2% Ca and 0.4% Ba. In view of the hardening effect of these elements there can be little doubt that these grains were solid solutions. These results definitely indicate that barium does form solid solutions in lead and reinvestigation of the system in a manner similar to that used by Schumacher and Bouton on the lead-calcium alloys will probably confirm the presence of solid solutions. Barium is body centered cubic in structure, while lead is face centered cubic, but this should not prevent them from forming limited solid solutions at least. Calcium and barium have atomic units of nearly the same size, but calcium differs from barium in being face centered cubic same as lead.

On remelting lead-barium alloys there is a much greater tendency for loss of barium than there is in the case of the lead-calcium alloys owing to the more rapid oxidation of barium. Whether or not addition of some other metal will serve to prevent this oxidation, as was reported for Frary metal, is an interesting point that appears not to have been investigated. Because of the instability of the alloys, satisfactory bearing metals cannot be produced by barium and lead alone. Small amounts of barium do not produce the necessary hardening and when larger quantities are added the alloy oxidizes spontaneously.

Barium unquestionably hardens lead to approximately the same extent as calcium but definite hardness values have not been recorded. Cowan states that even 0.08% barium makes lead resonant. Calcium and barium together are also said by Cowan to produce greater hardening than the same total quantity of either one alone, thus indicating that the extent of the hardening effect of each separately was known, at least qualitatively, but no values were given. The hardness of Frary or Ulco metal, as well as certain other alloys containing calcium and barium, are given in Table 1.

Table 1

				Brinell (500 kg.) after		
Ba	Ca	Hg	Pb	1 hr.	7 days	28 days
0.40	0.77	..	Balance	13.8	21.8	24.5
1.00	0.50	..	"	18.7	22.2	23.5
1.20	0.77	..	"	17.6	26.1	28.4
2.00	0.77	..	"	25.7	29.2	31.5
1.00	0.50	0.2	"	22.6	24.4	24.7

$\frac{5}{32}$" dia. ball, 40 kg. load for 30 secs.

The effectiveness of the alkaline earth metals in hardening lead is thus shown. Increasing the percentage of barium increases the hardness but the age hardening is not increased proportionately. Definite values for the hardening effect of various amounts of barium alone on lead, as well as the extent of age hardening produced thereby, would be of interest.

The effect of barium on the tensile, fatigue, and creep strength of lead has not been determined.

Even less is known about the lead-strontium system than about the analagous calcium and barium systems though strontium has been used to some extent in commercial alloys. Piwowarsky[10] claimed that a lead-strontium-calcium alloy was superior to Frary or Lurgi metal. He made some investigation of lead-strontium alloys and found the system to closely resemble that of lead-calcium. The melting point rises rapidly to a maximum of 670° C. at 12.35% Sr, which corresponds to the composition of the compound Pb_3Sr. There is an eutectic but it contains only a very small amount of strontium, the eutectic temperature coinciding approximately with the melting point of lead. Piwowarsky reported the strontium to be insoluble in lead but here again it appears that reinvestigation is needed before any definite conclusion can be drawn. Possibly a peritectic reaction and solid solution exist similar to those in the lead-calcium alloys. The eutectic is so close to the melting point of lead that it may be difficult to distinguish either a peritectic or solid solution.

No results are available on the hardening effect of strontium, loss on remelting, segregation tendencies, stability of alloys, or other characteristics enumerated above in the consideration of the other systems. In view of the greater cost of strontium it appears that its effects would have to be greater than those of calcium to make it attractive from a cost standpoint, but the fact that it is chemically less active than barium ought to be an advantage.

The lead-sodium system has been worked out quite completely at the lead end as shown in Fig. 3. The addition of sodium lowers the melting point to 307° C. At this temperature the eutectic, containing 3.3% sodium, exists. A compound Na_2Pb_5 forms at about 4.25% Na but this is beyond the range of any alloys used for bearings. The eutectic, consisting of compound and solid solution, surrounded by excess solid solution of sodium in lead is the only structure to be expected in the commercial alloys, which contain little more than 1% sodium. At the eutectic temperature 0.8% of sodium can be held in solid solution but the quantity decreases as the temperature falls. The exact course of the solvus line has not been charted

Goebel[11] found sodium to be a more effective hardener for lead, up to 0.8% where the hardness reaches its maximum, than are As, Cd, Sn, Hg, or Bi. Thieme (Table 2) confirms the 0.8% limit for maximum hardness and reports it as 8 Brinell (100 kg-10 mm. ball).

Table 2. Hardening Effect of Various Elements Upon Lead

Cu	Sn	Pb	Sb	P	Mg	Ca	Na	Ni	As	Hg	Brinell
...	...	99	...	...	...	0.8–1.0	...	...	...	...	15
...	...	99.5	...	...	...	...	0.5	...	...	...	5-6*
...	...	99.2	...	...	...	...	0.8	...	...	...	7.5-8*
...	...	99.5	...	...	...	...	...	...	0.5	...	7.5-8.5*
...	...	98	...	...	...	...	...	2.0	...	...	....
...	...	90	10.0	...	...	...	...	...	...	...	14
...	...	82	18.0	...	...	...	...	...	...	...	16
0.8	Tr.	81	18.0	.15	...	...	...	...	...	...	24
...	...	82	17.5	...	0.5	...	...	...	...	...	17.5
...	0.5	82	17.5	...	...	...	...	...	...	...	15.5
...	4.0	82	14.0	...	...	...	...	...	...	...	18
...	5.0	81	14.0	...	...	...	...	...	...	...	19
...	8.0	80	12.0	...	...	...	...	...	...	...	20-21
...	11.0	75	14.0	...	...	...	...	...	...	...	22
...	...	99.3	...	...	0.7	...	...	...	...	...	15
...	1.0	98.3	...	...	0.7	...	...	...	...	...	12
...	2.5	96.8	...	...	0.7	...	...	...	...	...	10.5
...	5.0	94.3	...	...	0.7	...	...	...	...	...	12
...	...	Balance	...	...	...	...	...	...	...	0-7.0	4-9*
...	...	100 (cast lead)									4-4.5*
...	...	100 (cold hammered lead)									5-5.5*

* 100 kg.—10 mm. ball. All others 500 kg. and 10 mm. ball.

The results given below from unpublished work by O. W. Ellis show how effectively small amounts of sodium raise the strength and reduce the ductility of lead.

Sodium %	Maximum Stress	Elongation % in 2"
Nil	3,360	40
0.5	12,300	18
1.0	15,000	13

The alloys are subject to age hardening but whether it is the precipitation of the compound Na_2Pb_5 that accounts for the hardening has not yet been determined. Zintl and Harder,[12] on the basis of X-ray examination, suggest that the hardness is due to a contraction of the lead lattice by solution of sodium, even though the sodium atom is larger than the lead atom.

Physical values for lead-sodium alloys are not numerous but it happens that a lead-sodium alloy was marketed around 1905 as a bearing metal and some physical properties for this particular alloy were reported. The metal was known as "Noheet", and it was claimed that it had the same lubricating qualities as pure lead and a lower coefficient of friction than any other bearing metal. An analysis, referred to as being made by E. S. Sperry,[13] showed the following composition: Pb 98.51, Na 1.30, Sn 0.08, Sb 0.11, the latter two being impurities.

Physical properties were reported as follows:[14]

Elastic Limit	11,000 lbs./in.^{2}
Tensile Strength	13,000 to 15,000 lbs./in.^{2}
Compressive Strength	22,000 lbs./in.^{2}

This is surprisingly high strength in view of the type of alloy involved and shows very definitely the profound effect of small amounts of sodium on lead.

Although "Noheet" had sufficient strength and hardness for many bearing applications it never was very successful owing to the rapid corrosion when exposed to the atmosphere. Resistance to atmospheric corrosion decreases with an increase in sodium content and dampness promotes rapid deterioration. It was necessary to coat the bearings with oil or other material to prevent corrosion in storage. Further, the alloy lost its hardness on remelting due to loss of sodium and, consequently it was not well adapted to the ordinary routine for handling lining metals. Later developments led to sodium and calcium being used together in a lead alloy with small amounts of lithium and aluminum. This is the Bahn-metall in use on the German State Railways today. The lithium is effective in reducing the tendency to atmospheric corrosion so that the alloy is commercially practical. Lithium also is a very effective hardener even when used in such a small quantity as in Bahn-metall. It thus becomes doubly effective since by its use the amount of sodium can be reduced without loss of hardness in the finished bearing.

The lead-lithium system was investigated in part by Czochralski and Rassow.[15] Above 2.2% Li the alloys have low resistance to corrosion and hence have no interest in connection with bearing metals. The system is similar to that of lead and sodium but there are some complications beyond the lithium content of 2.1% and no conclusive diagram can yet be drawn. There is an eutectic at 0.65% of lithium and at a temperature of 230° C. The compound Li_2Pb_8 appears to exist at about 2.1% lithium. This is entirely similar to the other systems described above. There is, in addition, a solid solution which appears not to exceed 0.09% Li, thus being in the order of the solubility of calcium rather than of sodium. No physical properties are given for the alloys except to mention that they are stable up to 2.2% Li, are harder than lead, and their properties are altered by aging. The addition of lithium in Bahn-metall to increase the corrosion resistance can be understood in the light of the results above. The solid solutions and eutectic which exist up to 2.1% have properties of a different character from those of the phases above this concentration. The 0.04% Li used in Bahn-metall undoubtedly is all in solution in the lead.

Mercury and lead alloy completely up to 33% of Hg at 38° C. Below this temperature the solubility falls off to an undetermined extent but as only very small amounts have been used in the bearing alloys, it can be safely said that under these conditions the mercury all goes into solution in the lead. It is an effective hardener, as shown by Thieme, raising the hardness proportionately from 4 to 9 as the mercury is increased to 7.0%. (The Brinell was taken with 100 kg. and a 10 mm. ball). It also acts as a hardener in Frary metal as shown in Table 1. Patents covering additions of mercury to lead alloys have been obtained.

Other metals may be added to the lead alkali-alkaline earth alloys for various purposes but generally in small amounts with the exception of tin. Magnesium, copper, zinc, and aluminum are favored. Copper is a hardener, while aluminum is generally credited as being an anti-drossing agent. Magnesium forms an eutectic and a compound with lead, resembling barium in this respect. The binary appears not to have acquired any commercial use but it seems to have possibilities that may not have been fully appreciated. Magnesium hardens lead considerably when added in only small amounts, 0.5% being sufficient to raise the hardness to 15 Brinell. The hardening agent probably is Mg_2Pb. Magnesium is not readily alloyed with lead but it does not easily oxidize once alloying has been accomplished. A small amount of aluminum in the alloy greatly increases the resistance to oxidation.

(Concluded in the next issue.)

Bibliography

[1] H. Caron. *Liebig's Annalen*, 1859, page 111.
[2] L. Donski. *Zeitschrift für anorganische Chemie*, Vol. 57, 1908, pages 185-219.
[3] N. Barr. *Zeitschrift für anorganische Chemie*, Vol. 70, 1911, pages 352-394.
[4] E. Schumacher & G. Bouton. *Metals & Alloys*, Vol. 1, 1931, page 405.
[5] C. Thieme. *Journal Industrial & Engineering Chemistry*, Vol. 12, 1920, pages 446-448.
[6] *University of Illinois Bulletin*, No. 243.
[7] A. M. Bochvar. *Journal Russian Metallurgical Society*, Vol. 1, 1925, pages 137-139, abstracted in *Journal Institute of Metals*, Vol. 34, 1925, page 433.
[8] J. Czochralski & E. Rassow. *Zeitschrift für Metallkunde*, Vol. 12, 1920, pages 337-340.
[9] Wm. Cowan, L. D. Simpkins & G. O. Hiers. *Transactions American Electro-chemical Society*, Vol. 40, 1921, pages 27-49.
[10] E. Piwowarsky. *Zeitschrift für Metallkunde*, Vol. 14, 1922, pages 300-301.
[11] J. Goebel. *Zeitschrift für Metallkunde*, Vol. 14, 1922, pages 449-455.
[12] E. Zintl & G. Harder. *Zeitschrift für physikalische Chemie*, Abt. A 154, 1921, pages 47-91.
[13] Anon. *Brass World*, Vol. 1, 1905, pages 231-232.
[14] Anon. *Iron Age*, Vol. 95, 1915, page 1016.
[15] J. Czochralski & E. Rassow. *Zeitschrift für Metallkunde*, Vol. 19, 1927, pages 111-112.

METALLURGICAL RESEARCH

Should Suit Type of Research to Problem

By O. W. Ellis *

No. 6 in a series of Case Histories in Metallurgical Research

ROUGHLY speaking, holiday-makers may be divided into three classes—stay-at-homes, those who choose some more or less remote point as a center for their vacation activities, and those who map out for themselves a tour commensurate with their financial resources and vacation times. There is a striking similarity between research workers and holiday-makers in that some seem satisfied with much the same sort of activity as that in which the stay-at-home indulges; others, however, find the centers of their interest changed from time to time, while others plan for themselves investigations commensurate with their capacity and financial resources, making, as it were, the "grand tour" without let or hindrance from anyone.

It is open to question whether there is a strict comparison possible between the stay-at-home and the research worker at all, even though the stay-at-home may, like the early riser, add to his store of health, wealth, and wisdom. This is so because research suggests rather more movement, whether irregular or continuous, than is ordinarily involved in the doings of the home-loving vacationist.

That type of holiday-maker who chooses a center from which his "petits tours" shall radiate is worthy of a little thought. The majority of research workers with whom I have been acquainted have been of this type, though, unhappily for most, the time allowed them for "vacation"—that is, for the prosecution of work round any given point of the research field—has been all too short. In this connection, there appears to be a fundamental difference between the research worker and the holiday-maker; it is possible to conceive that in time continued visits to one particular point would result in the latter having exhausted the interesting possibilities in that neighborhood, whereas the former might conceivably never reach the limit of *his* grasp. That he could become wearied by continued contemplation of the same old scenes is as true of the research worker as of the holiday-maker. There is much to be said, therefore, for having more than one iron in the fire when it comes to research, though one may have too many irons in the fire and thus get scorched.

Assuming that the research worker is engaged on work of this type, the question arises, how many highways and byways shall he follow before giving up his investigations. This question, it is felt, cannot be satisfactorily answered in a general way; each particular field of investigation is a law unto itself. In these busy days there is a tendency, however, for work in a particular field to be abandoned before the research worker has become stale, this to the disadvantage of both the worker and those by whom he is employed.

It will be recognized that in this connection the research worker shares the responsibility with those by whom he is employed. Usually he is the one best fitted to argue the case for continued investigation in any particular field.

At this point a word of warning might be uttered to those workers in metallurgy who are mainly interested in the development of alloys of the commoner metals. There is a tendency for them to overlook the possibilities of the rarer metals in their work. The writer has in mind a case where the investigation of the characteristics of certain alloys was undertaken with considerable success. Had the work been carried to the point where a relatively rare element had been added to the alloys which were the subject of investigation, a whole field of useful alloys would have been uncovered to the advantage of all concerned. Here was a byway that was unexplored, not because it

* Director of Metallurgical Research, Ontario Research Foundation, Toronto, Canada.

was considered unattractive, but because the cost of its exploration was felt by the research worker, himself, to be excessive. Because of his inaction, a competitor, whose research workers were more adventurous, entered this field. While no figures are available from which to determine how the profits resulting from the earlier work were divided between the two firms, divided they were—and are!

It is clear that the executive should share with the research worker the responsibility for discontinuing investigations in any particular field. Some workers "stale" before others. In general, the executive can determine whether this staleness is a symptom of laziness or not. A word of encouragement or advice may alter the entire outlook for the research worker who shows signs of weariness, just as the mention of a point of interest, unheard of or overlooked, may bring a holiday-maker back to old haunts for yet another visit.

A repeated visit of the type just mentioned is generally made for some specific purpose. This purpose having been accomplished, it seems to the writer that in most instances it would be well to abandon the particular field of investigation—if not entirely, at least for some time. The point should be made here that not all investigations reach definite conclusions, but that when definite conclusions have been reached, a return to the field is generally made for the purpose of obtaining other such conclusions.

A few points may be raised regarding the "grand tour" type of investigation. This can rarely be accomplished by the individual worker. What we know of the fundamentals of the heat treatment of steel for example, is the result of research work extending over the best part of a century. It is conceivable, though most unlikely, that under the leadership of one man this work could have been accomplished in less time, the tendency being for the individual research worker engaged on a "grand tour" to turn aside from the main road and investigate this and that attractive byway. His reason for doing so is not far to seek. Grand tours can breed boredom just as surely as can continued visits to the same old spot. There is, in fact, less likelihood of weariness resulting from repeated visits at reasonable intervals than from continued journeyings along new roads. Research work, to be of any value at all, should embody some of the characteristics of vacations. In other words, the worker should enjoy his work.

Reverting to the difficulty of always arriving at definite conclusions, the writer and Prof. G. B. Karelitz conducted a very extensive study of the tin-base bearing metals in the hope that they might be in a position to recommend definitively certain mixtures of tin, antimony, and copper as being best suited for bearings of certain types. The writer was mainly concerned with the metallurgical aspects of the work—investigating casting phenomena, obtaining cooling curves (using both thermal and electrical methods), examining the microstructure of alloys cast under a variety of conditions, testing the hardness at room temperature, and determining the effects of cold work on these alloys. In passing, it may be noted that pounding tests were also conducted; but, since the results of these tests were so variable, they were unrecorded—even though a definite relationship seemed to exist between the hardness numbers and the number of blows required to produce certain definite percentage deformations in standard samples of these alloys. Certain definite conclusions, of course, were reached. The contours of the liquidus surface of the tin corner of the tin-antimony-copper system were arrived at. An isoscleric diagram for the alloys at room temperature was prepared, the effects of copper and antimony upon the characteristics of the alloys at varying temperatures were determined, and definite relationships were established between the proportional limits, yield points, ultimate strengths, and hardness numbers of these alloys. Prof. Karelitz, as a result of his work, was able to show that the presence of lead in these alloys had an important effect upon their behavior as linings in bearings. This effect was shown to be due to the fact that when the temperature of a bearing reached 180° C., such portions of the alloy as were present in the form of tin-lead eutectic melted out and were smeared over the inside of the lining. But to the specific question—"What alloy would you recommend for *this* service or for *that* service?"—the authors found they had no answer, though they could make the suggestion that it appeared desirable to avoid the use of such alloys as might vary in structure according to the rate at which they were cooled. Such alloys were those which at room temperature lay in the neighborhood of the line in the ternary diagram separating those consisting of CuSn + solid solution + eutectic and CuSn + SnSb + solid solution + eutectic. It is not felt that the metallurgist should be criticized for his inability to answer such questions as the above. Both the metallurgist and the engineer should share the responsibility for deciding upon a particular composition, since it is the engineer who has the best chance of following up the behavior of individual alloys in actual service.

The above remarks apply to much of the work which the metallurgist is called upon to do. It is obvious, of course, that where knowledge has become crystallized by practice, the metallurgist should *know* and, knowing, should be prepared to accept the responsibility for whatever may come of the application of his knowledge; but in pioneer work all that the metallurgist can reasonably be expected to do is to provide information regarding the characteristics of certain alloys and to make suggestions (but suggestions only) as to their possible usefulness in certain situations.

It occasionally, though rarely, happens that the research worker is unfavorably situated for following up work which has been based upon his findings. This is particularly true of research workers in laboratories remote from the plants in which the results of their investigations are being applied. Even in such cases as these, the writer feels, the executives of the laboratory or the individual research worker, himself, should accept the responsibility for seeing that the results of their work are being used to the utmost. It should be remembered that improvements are constantly being thought of by those employed in applying the results of research. Many of these "improvements" are such that the research worker can at once decide as to their uselessness. It is rarely that the whole story is told in the research reports which emanate from the laboratory. Only those findings which are considered of vital importance are included in such reports. Negative methods and negative results are frequently unmentioned—not because the research worker has the desire to cover up any of his work, but because of lack of time and, sometimes, lack of space in which to deal with everything that he has accomplished. The plant executive must not be blamed if, having no information regarding negative results, he puts his hand to try some experiments himself.

(Continued on page 175)

Enameling Iron

Its Behavior In Enameling

By Karl Kautz *

WHEN PORCELAIN or vitreous enameling was first introduced into this country the only sheet steel available for a base was tin mill black plate. This product was used for many years with fair success, but as the enameling industry grew the enamelers demanded a better sheet—one to which enamel would bond firmly with little or no warping and blisters. The steel makers met this demand by furnishing a purer form of iron for their sheets and by special processing.

Today, sheets for porcelain enameling are almost pure iron. An average chemical analysis of enameling iron will show approximately 99.85% iron (ferrite), the remaining 0.15% impurities being distributed between carbon, manganese, sulphur, phosphorus, silicon and copper. Not only is the chemical composition of the iron carefully controlled but the processing (rolling, heat treating, pickling, etc.) is just as painstakingly performed.

Enameling iron is made in two grades, regular for all flat work and deep drawing for those parts which require excessive forming. The regular grade, because of its larger grain size, does not easily warp or sag in firing of flat work; it is used only for shallow forming or drawing. The deep drawing grade of smaller grain size tends to wrap when fired on flat work, but is suitable for difficult drawings which are usually rigid enough, after forming, to prevent warping.

Enameling iron is not a standardized product. Each customer's requirements are carefully studied and then the physical properties, flatness, surface, gage and size of sheet to meet these requirements are furnished. Complete records permit duplication of any particular order.

Physical Properties

Since enameling iron is a tailor-made product, the physical properties vary within certain limits. The routine physical tests made on enameling iron sheets include (a) grain size, (b) Rockwell hardness, (c) Olsen cup test, and (d) tensile strength. Tensile strength tests are made only in exceptional cases.

(a) Micro analysis and grain size. These observations are made on a polished and etched section parallel to the direction of rolling, using a magnification of 100 diameters.

Fig. 1. Typical enameling iron grain structure. This structure, however, should not be construed as a standard for this can be made to vary considerably between wide limits. Magnification 100×.

(b) Rockwell hardness. These values are obtained on the Rockwell testing machine, using the "B" scale. A typical value is 40, but again this will vary within wide limits according to processing and the requirements to be met.

(c) Olsen Cup Test. On 20 gage material, a typical value of this test shows .380", ranging considerably below and above this figure according to specific requirements.

(d) Tensile Strength. Typical values of this test show 48,000 lbs./in.^{2} for tensile strength, 30,000 lbs./in.^{2} for elastic limit, and 26% elongation in 8 inches. These values, however, will vary considerably according to the processing of material

Surface Texture and Finish

To meet certain requirements, enameling iron sheets are made in various surface textures and finishes. These are briefly described below.

Smooth cold rolled texture is produced on a sheet by means of smooth or polished cold rolls. Very few enamelers prefer this texture for ordinary work. It is used, however, in special cases.

Rough cold rolled texture is produced on a sheet by means of etched cold rolls, or rolls roughened or dulled by other suitable means. This texture is most in demand by enamelers because it aids greatly in the application of the ground coat enamel slip.

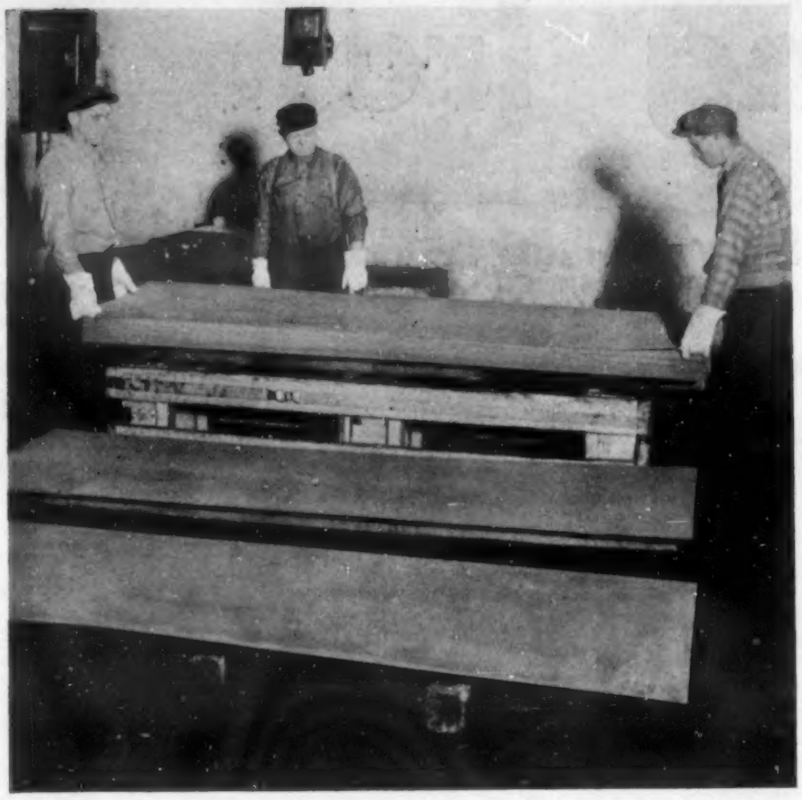
Etched texture is produced on a sheet by deep selective pickling in various acids or combinations of chemical reagents. This texture is used by many enamelers. A roughed or etched surface is thought by many to improve the adhesion of the ground coat.

White finish refers to the color of the sheet. This is produced by carefully washing and scrubbing all oxides and smudge from the sheets as they come from the pickling operations.

Dull golden finish is produced by an alkaline neutralizer following the pickling operations or by drying the sheets from the scrubber or cold rolls at a high temperature.

Oiled sheets are furnished in few instances. Oiled sheets should be used where severe rusting conditions prevail or where formed ware is stored for considerable periods before enameling. This oil is easily removed by the alkali cleaning solution through which all enameled parts must pass.

* Ceramic Engineer, Republic Steel Corp., Massillon, Ohio.



A Regular Crew consisting of an inspector and two helpers giving the final inspection to a lift of enameling iron sheets. Both sides of each sheet are inspected. Primes are stamped by the inspector with a rubber stamp.

Changes in Physical Properties Due to Enameling

Tests made on enameling iron which had been enameled in the usual manner and the enamel removed show but slight changes in its physical properties. The firing of ground coat enamel at 1600° F. for 5 minutes tends to further anneal the sheet, causing a slight grain growth and a lowering of the Rockwell hardness and Olsen cup penetration. The firing of the first and second white cover coats at 1550° and 1500° F., respectively, reveals similar changes in the enameling iron base, but to a far less degree. A light oxide coating is produced on the surface of the iron during the initial firing of the ground coat.

These very slight changes which occur in enameling iron during the enameling heat treatments explain why defective enameled parts can so easily be de-nameled and re-enameled without serious difficulty, though such re-treatment is often more costly than scrapping the defective part, so that either reclamation or scrapping will be practiced according to individual circumstances.

The Adherence of Ground Coat Enamel to Iron

The enamel used as a base coat in vitreous enameling may be described as a potassium sodium calcium aluminum boro-silicate glass containing a small percentage of adhering oxides in solution. These adhering oxides usually consist of cobalt and manganese oxides and in some cases nickel oxides. The glass quite often contain a small amount of fluorine.

This glass ground with water and a small amount of clay to aid in suspension is applied by dipping the cleaned pickled iron article into the suspension. After drying, a heat treatment for 4 to 5 minutes at 1600° F. fuses the glass which then adheres tenaciously to the iron surface.

There have been a number of theories advanced to explain why this fused glass should adhere to an iron surface so firmly. These theories may be roughly classified under the following heads: (a) gripping, (b) oxide layer, (c) dendrites and (d) electrolytic reactions.

(a) The gripping theory maintains that adherence is brought about by the enamel penetrating the pits and depressions and inclosing other surface irregularities on the iron. It may be compared to glue filling the pores of wood.

(b) The oxide layer theory maintains that the cause of adherence is due to a solution bond between the enamel and a layer of iron oxides formed on the surface of the iron. This would mean that two forces of adhesion are in operation, one between the metal and the scale formed on it and the other between the scale and the enamel glass.

(c) Numerous dendrites of alpha ferrite have been found in the fired ground coat enamel when examined under a metallographic microscope. The dendrite theory maintains that iron oxide goes into solution in the ground coat enamel and is later reduced to the metallic state, crystallizing out as alpha ferrite. These dendrites of alpha ferrite are assumed to "spike" the enamel layer to the iron surface.

(d) The electrolytic theory maintains that iron, being higher in the electromotive series than cobalt, replaces the cobalt in the cobalt silicates of the glass, the cobalt precipitating as metal and the iron going into solution as iron silicates. Thus the iron oxide layer would be completely dissolved and a solution bond between metallic iron and the enamel developed, whereby dendrites of cobalt would be produced.

Testing Adherence of Enamel to Iron

There are two methods used to estimate the adherence of ground coat enamel to iron. These may be described as the (a) impact and (b) cross bending tests.

In the impact test a weight attached to a rounded or semi-spherical punch head is allowed to drop on the enameled iron sample with sufficient force to produce a cup depression. This weight may be attached to a pendulum or it may be a freely falling body. In either case the adherence is estimated from the amount of enamel remaining in the depression. Sometimes the enameled iron is treated repeatedly with light blows until failure occurs, the number of blows being recorded as an index of adherence.

In the cross bending test, an enameled iron strip is deflected until the enamel fails; the amount of deflection in this case is sometimes taken as a measure of the enamel adherence, but is probably a less direct measure of it than the impact test.

Unfortunately both these tests depend upon deformation of the metal. No method as yet has been devised which successfully measures the force required to part the enamel from the iron base without deformation of the latter. However, the above tests are useful in comparing the adherence of various ground coat enamels upon a particular iron or in a study of firing conditions using the same enamel and iron, but give erratic results when various irons having widely different physical properties are tested with a standard enamel under standard firing conditions.

Gases Evolved from Enameling Iron When Heated

When enameling iron is heated in vacuo gases are evolved at a red heat and continue up to and including the melting temperature of the iron. Spectrographic analyses of these gases show that above 1300° F. carbon monoxide is the principal constituent with smaller amounts of nitrogen and perhaps carbon dioxide. Be-

low 1300° F., in addition to the above named gases, some hydrogen and water vapor are present in the mixture. It is believed that occluded hydrogen is evolved at low temperatures, and is partially oxidized to water vapor in the presence of iron oxides. The carbon monoxide is believed to be evolved from a continuation of the rimming reaction.

$$Fe_3C + FeO \leftrightarrows 4\ Fe + CO$$

and is partially oxidized by iron oxides to carbon dioxide, thus

$$CO + FeO \leftrightarrows Fe + CO_2$$

The nitrogen is evolved either from a state of occlusion or from decomposition of iron or manganese nitrides. Quite often it appears in the spectrum as cyanogen, possibly due to a reaction between carbon oxides and nitrogen under the influence of the electrical discharge in the spectrum tube.

The evidence seems to indicate that these gases, particularly carbon monoxide, are instrumental in causing a boiling of the ground coat enamel when fired.

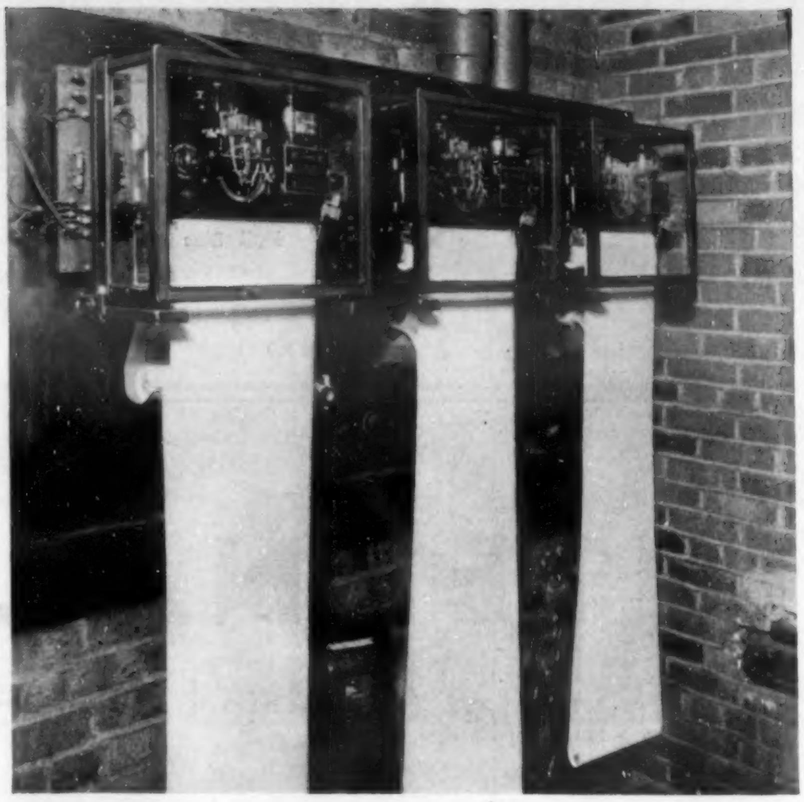
Reboiling and Black Specking

In firing ground coat enamels applied to iron, there is a period above 1200° F. during fusion of the enamel particles when considerable evolution of gas as bubbles occurs and which is known as primary boiling. These bubbles later subside leaving a smooth, glassy surface when the heat treatment is complete. If allowed to cool to room temperature and reheated, there will be another evolution of gas when the enameled article reaches the softening temperature of the enamel. This is apparent by the appearance of numerous bubbles of gas on the enamel surface which later rise, burst and subside as the temperature increases leaving a smooth glassy surface as in the previous heating.

This phenomenon, known as secondary boiling or reboiling, has been blamed for the black specks which sometimes occur in the white cover coats. The fact, however, that white cover coats entirely free from black specks can be and are formed on ground coat enameled iron which show this reboiling tendency, seems to indicate that black specking from this source is quite negligible. In general it may be said that reboiling is an unnecessary but quite harmless phenomenon in enameling. The writer has found that black specking of white cover coats is caused preponderantly by (1) copper heads, (2) burning off of ground coat enamel, (3) too thin an application of ground coat enamel, (4) improperly cleaned and pickled iron, and (5) carbonaceous material such as wood, paper or textile fibers being ground into the white and ground coat enamels or left on the iron surface.

Desirable Qualities in Enameling Iron

Enameling iron first of all should enamel satisfactorily. Various commercial ground coat enamels should fuse smoothly on its surface, giving rise to a firm tenacious bond. It should show no "pickle blisters" under typical pickling conditions and should have minimum warpage on formed ware under severe heat treatments. Enameling iron sheets should have a dull, slightly roughened surface texture to which ground coat enamel slip will cling and drain smoothly, and to which the fired ground coat will bond firmly. This surface texture, however, should be such that the removal of oil, grease and drawing compounds by the cleaning solutions will not be impaired and the action of dilute acids upon the metal will not be hindered.



Bank of Automatic Temperature Recorders for recording temperatures at various points in the sheet normalizing furnaces.

By varying the processing, the physical properties of enameling iron should be adjusted to meet the requirements for drawing, forming, or spinning in a satisfactory manner.

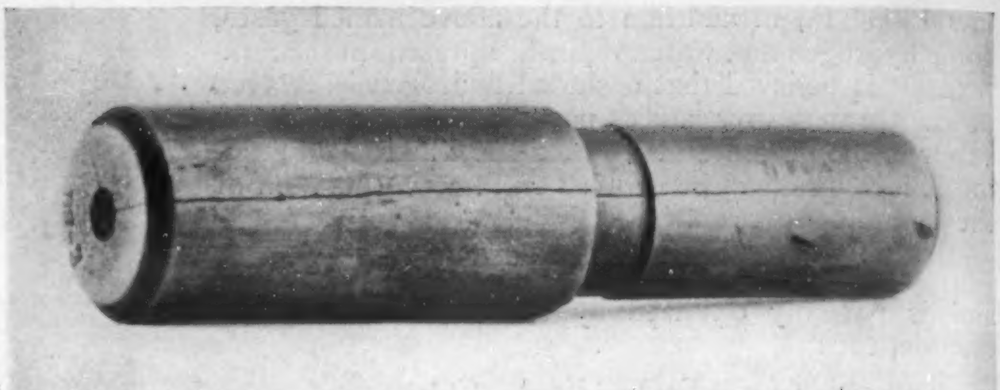
Stanley A. Knisely, of Cleveland, has been appointed advertising and sales promotion manager of the Republic Steel Corporation with headquarters at Youngstown, Ohio. He succeeds L. S. Hamaker who was recently made vice-president and general manager of the Berger Mfg. Co., Republic subsidiary of Canton, Ohio. Knisely entered newspaper work in his home city of Canton, Ohio, and later held the positions of city editor and telegraph editor of the Cleveland Plain Dealer. He left the newspaper field to become advertising and sales manager of the National Paving Brick Association, with headquarters in Cleveland. After 6½ years in this position, Knisely became director of advertising research for the National Association of Flat Rolled Steel Manufacturers and served 7 years in this capacity.

C. D. Dallas, President of Revere Copper and Brass Incorporated, announces the appointment of C. A. Macfie and C. C. Felton as Vice-Presidents of the company, with offices at the Executive Headquarters in the New York Central Building, 230 Park Avenue, New York. Mr. Felton was formerly Sales Manager of Calumet & Hecla Consolidated Copper Company.

The appointment of **K. B. Bowman** as General Superintendent of the Steel Mill is announced by the Timken Steel & Tube Company. Mr. Bowman was graduated at Case School of Applied Science in 1921 and immediately became associated with the steel industry. He has been with the Central Steel Co., Central Alloy Steel Co., and Republic Steel Corp., his experience covering metallurgical and operating practice in various phases of the industry. In 1931 Mr. Bowman joined the Timken Steel & Tube Company in the capacity of special statistician for Mr. F. J. Griffiths, President, later being made manager of the Statistical Department of the Company. In 1933 he was promoted to Director of Production, in which capacity he acted until his appointment as General Superintendent of the steel plant.

Crack in Tool Steel, Probably Produced by Internal Stresses Resulting from Quenching. (Courtesy of Howard Scott).

Full Size



INTERNAL STRESSES

Part Three of a Correlated Abstract in Five Parts by Charles S. Barrett†

2. THE PERIPHERAL WIDENING OF SPOTS

If the X-ray beam in an apparatus such as that sketched in Fig. 8 contains only a single wave-length (or contains strong monochromatic radiation superimposed on the general or "white" radiation) and falls on a polycrystalline specimen, the pattern formed on the photographic film will consist of a series of rings. These rings will be composed of individual spots, each spot being caused by a ray diffracted from a single grain in the specimen. The size of each spot will be determined by the size of the grain causing it (provided the grain is entirely bathed in the X-ray beam), by the angular divergence of the incident beam, and by the distortion of the lattice of the reflecting grain.

If the specimen is in a condition which produces, with general radiation, a Laue photogram exhibiting asterism, it will produce with monochromatic radiation a related pattern of spots, each spot of which will be a section through the corresponding streak of the Laue photogram. Each spot will be, in fact, that portion of an asterism streak formed by the monochromatic radiation in the beam. If the distortion of a grain is a bending or rotation of fragments about the incident beam as an axis, a Laue photogram of it will contain striae, all of which are arcs of circles concentric about the primary beam. In this case a spot on a Debye ring from the grain will be elongated peripherally the full length of the Laue streak. With any other orientation of the bending axis, the peripheral widening will be less than the full length of the Laue streak; it will represent, in fact, that component of the range of orientation in the beam which consists of rotation about the primary beam as an axis.

Below the elastic limit of each grain involved, the appearance of peripheral widening reveals stresses that are distributed so as to cause a bending of atomic planes. With deformations exceeding the elastic limit, peripheral widening increases with the deformation in the same way that asterism does, and reveals not the internal stress in the object, but the distortion of the grains. Goucher[49] extended large crystal and single crystal tungsten wires and measured the peripheral widening vs. per cent reduction in diameter. While the results showed much scattering, it was clear that at least an approximate linear relationship was present from 0 to 40% reduction in diameter.

While peripheral widening accompanying plastic deformation has been observed by X-ray workers for some years, it is only recently that it has been proposed as a means of measuring the amount of deformation quantitatively Regler[50] measured the peripheral widening of spots for large angle diffraction lines as a function of the amount of deformation, taking as his figure for the peripheral width the average width of the 30 widest spots. Plotting these values of width against the deflection in millimeters of a 6 mm. mild steel specimen bent between two supports spaced 10 cm. apart he obtained the curve of Fig. 16. The line is remarkably straight from zero deflection up to deflections at which the spots begin to overlap. It is surprising that the curve shows no change in slope at the yield point, for one would expect different relations between deformation and lattice rotation above and below this point.

Regler proposes taking the average peripheral width of spots as a sensitive measure of stress (within the elastic limit). For this purpose it would be necessary to calibrate the camera by applying known stresses to the material under the same temperature conditions in which it is to be used, for the method could not measure stresses directly. The peripheral width reveals lattice rotation occurring on a microscopic scale—within individual grains—and is but indirectly related to macroscopic stresses, the relation varying with the stress distribution, the temperature, and the material. As with the precision parameter methods of Sachs and Weerts, and of Wever and Möller to be discussed later, information is obtained from the surface layers only; in order that these be in a suitable condition Regler recommends an etching of the surface, the depth of etching being unimportant as long as the surface layer is removed.

It is difficult to make a fair appraisal of the method at this time. One cannot accept without confirmation Regler's extravagant claim[51] of an accuracy in stress measurement of 0.1 kg./mm.^{2} (142 lbs./in.^{2}), nor his claim[50] of an accuracy of 0.001 mm. in a measurement of average spot width for 30 spots which vary in width from 0.22 to 0.77 mm. On the other hand

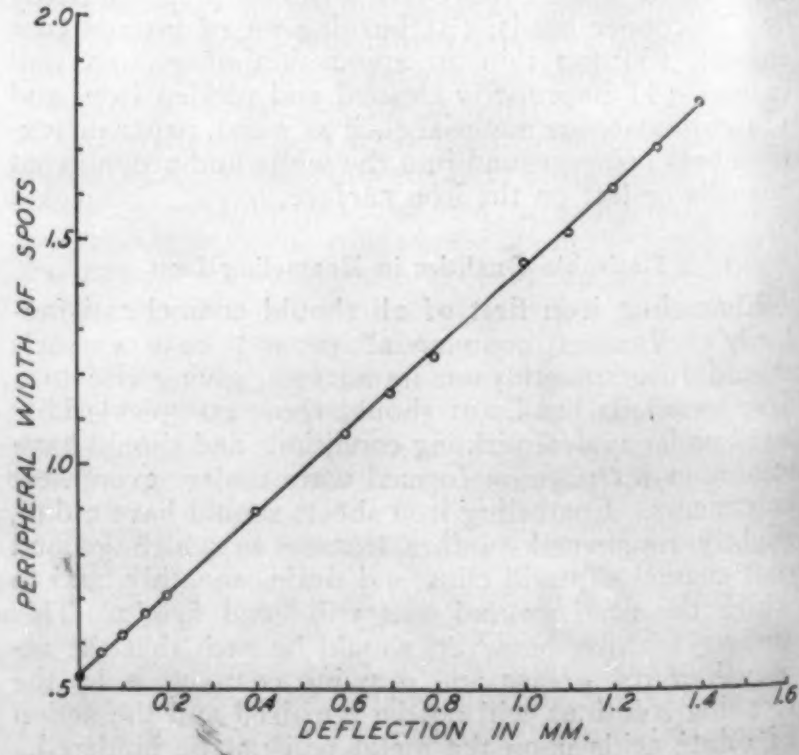


Fig. 16. Relation of peripheral width to strain. (Regler)

† Metals Research Laboratory, Carnegie Institute of Technology.

it is obvious that the method has the advantage of small exposure times (1 to 15 minutes) and relative independence of errors in specimen to film distance. A simple camera suffices, for film and specimen are stationary: Regler uses back reflection cameras with conical or cylindrical film holders through which the beam is sent axially and falls perpendicularly upon the surface to be tested.

Strain Lines in Steel

An interesting field for study with this method is that of plastic deformation in iron and steel. Two different results have been obtained with this method applied to strain markings in steel. Fell[52] reported a marked difference in character between the photograms from strained and unstrained areas of a steel sample showing Lüder lines. In his published photograms individual spots are seen in the Debye rings from unstrained material; these are widened peripherally and overlapping in the case of the Lüder line material. Rawdon,[53] on the contrary, finds no difference in photograms from annealed low carbon steel inside and outside of Lüder lines. Peripheral widening should have been readily recognized on his published photograms, had it occurred in any marked degree. Regler's observations on peripheral width are in line with Fell's observations rather than Rawdon's, for he shows widening increasing with deformation. In Regler's case, however, the nature of the conditions in the specimen is so different that direct comparison is inconclusive.*

Summary

Spots on Debye rings from strained metals represent sections through asterism streaks; their peripheral width is related to conditions in the metal in practically the same manner as is asterism in Laue photograms. Regler has proposed the average peripheral width of spots as a quantitative measure of uniaxial surface stress, and has claimed remarkable accuracy (142 lbs./in.^{2}) for the method; independent estimates of the accuracy are not yet available. Undeniable advantages of short exposure time and simple apparatus are to be weighed against the inconvenience of calibrating the apparatus with known stresses for each material investigated (for the method is not an absolute measure of stress). Nothing has been published on the effect of biaxial stresses on the results obtained; furthermore since the method reveals only the stresses at the surface, it is not serviceable for the measurement of three-dimensional stress distributions.

3. RADIAL WIDENING OF LINES

As mentioned in the previous section, diffraction of monochromatic X-rays from a powder or a fine-grained metal (the Hull-Debye-Scherrer method) produces on a photographic film a set of diffraction rings. The width of these rings, measured radially, is related to the intensity of microscopic stresses in the specimen. The rings may be considered as the result of superposing many rings, the diameters of which vary slightly on account of varying amounts of elastic deformation in the reflecting crystals. If all the reflecting grains are uniformly stressed by a macroscopic distribution of stresses, the diffraction lines will be uniformly shifted—the ring diameters uniformly changed—in accord with the laws discussed subsequently under the heading "The Shifting of Lines"; but if the region (a few square millimeters in area) irradiated on the specimen by the X-rays is under a stress distribution that is not of this homogeneous type but is, instead, microscopic, there will be a variable shift and a resultant widening.

Methods of Observation

The strongest characteristic lines in X-ray spectra are the $K\alpha_1$ and $K\alpha_2$ lines. The wave-lengths of these differ but little; for example, an X-ray tube with a copper target emits $K\alpha_1$ with a wave-length of 1.537 A. U. and $K\alpha_2$ at 1.541 A. U., a difference of about one part in 400; with a molybdenum target the difference amounts to about half this. A powder diffraction photogram is therefore a pattern in which the strongest lines are doublets, each doublet representing diffraction—at angles defined by the Bragg law—of $K\alpha_1$ and $K\alpha_2$ radiation from a certain set of atomic planes in the lattice of the specimen.

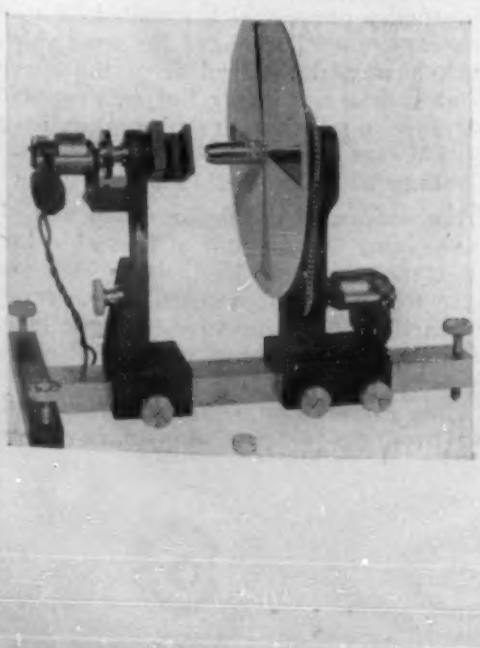


Fig. 17. Precision back reflection camera.

*Recent tests with a back reflection camera, in the Metals Research Laboratory, Carnegie Institute of Technology, have clearly shown the peripheral widening of spots from Lüder line material in deep drawing steel sheet.

Studying powder photograms of metals, Davey[54] and van Arkel[55] observed that cold working caused a widening of the diffraction lines sufficient in many instances to cause the lines of a doublet to overlap. Annealing the metals caused the doublet to be again resolved into its two components. Davey's observations were on doublets at small diffraction angles, van Arkel's at large angles (θ approaching 90°) where the separation of the lines of the doublet is much greater. Observation of the resolution of the $K\alpha$ doublet still continues to be frequently used as a criterion of line width.

For quantitative results it has become a common procedure to prepare a microphotometer trace of the lines and to measure the width of the trace at a certain fraction of the height of the peak. For this purpose it is advantageous[56] to use a back reflection camera such as is illustrated in Fig. 17 in which a plane film is mounted so as to rotate about an axis perpendicular to the film and parallel to the axis of the X-ray beam. Only high angle diffraction lines are recorded on the film. Rotation of the film, which removes the spotty character of the diffraction lines discussed in the preceding section, contributes greatly to the uniformity of the results; rotation of the specimen, which is also provided for in the camera, serves to bring more grains into position for reflection and thus effectively makes a desirably small grained sample out of a large grained one.**

Another criterion of line width which may be read from microphotometer traces is the ratio of the peak intensity of a line in a doublet to the minimum intensity between the 2 lines of the doublet.[57] As the lines are widened they overlap and raise the intensity in the region between them, reducing this intensity ratio.

Types of Doublets

A fact which has been little used in internal stress studies was discussed in this connection by Becker[58] some time ago. In the production of diffraction rings of the type that has just been described it is essential that the pinholes defining the X-ray beam be sufficiently small. In fact it is necessary in order to obtain these doublets, which Becker calls "van Arkel doublets," that the aperture angle of the incident beam—the angle subtended at the specimen by the pinhole or slit—be less than $(\theta_1 - \theta_2)/2$ where θ_1 and θ_2 are the diffraction angles for $K\alpha_1$ and $K\alpha_2$ radiation, respectively. If the pinholes be widened until the aperture angle is greater than $(\theta_1 - \theta_2)/2$, a single grain of the specimen can reflect both $K\alpha_1$ and $K\alpha_2$ simultaneously, which is not true with the narrower slit. The result is a pattern in which most of the usual spots are replaced by double spots of half the ordinary doublet separation. These paired spots Becker calls "Gerlach doublets." For internal stress studies where diffraction effects from individual grains are desired these "Gerlach doublets" may be advantageously used.

Theoretical Studies of Line Width

A number of factors may cause a widening of lines beyond the width required by the geometry of the apparatus: thermal vibrations of the atoms, small size of the reflecting particles, refraction of X-rays in the metal, inhomogeneity in composition of alloys, and inhomogeneous strain in the lattice. The separation of these effects is a difficult problem. Dehlinger's suggestion,[59] that widening from strain might be separated from particle size widening by the different dependence of these two effects on wave-length, now seems to hold little promise because of the occurrence of anomalous widening of certain lines in preference to others.[60] This will be discussed later in more detail.

A partial separation of the particle size effects from the strain effects may be made on theoretical grounds, using the assumption that all internal stresses must be within the elastic limit. If one calculates the amount of extension a lattice may undergo within the elastic limit and the shift in the angle of reflection that this extension should produce according to the

**For designs of back reflection cameras see Sachs & Weerts. *Zeitschrift für Physik*, Vol. 64, 1932, pages 334-358; 481-490.
Wever & Pfarr. *Mitteilungen Kaiser Wilhelm Institut für Eisenforschung*, Vol. XV, 1933, pages 137-145.
C. S. Barrett. *Metals & Alloys*, Vol. 4, May 1933, pages 63-64.

Bragg law, one then obtains a theoretical line width representing the maximum width attributable to stress. Greater widths than this maximum must be ascribed to a reduction of size of the reflecting particles to less than 10^{-6} cm. Wood[61] used a line of attack similar to this in attempting to separate strain effects from particle size effects in metals, determining the maximum width for strain not by theoretical calculations but by experimental observations on drastically cold worked metals. Observing that electrodeposited nickel gave wider diffraction lines than severely cold worked nickel, he concluded that the additional width from the electrodeposited metal must have been caused by smallness of particle size.

For purposes of internal stress study the widening of lines by refraction (the deviation of the index of refraction from unity) is of no importance because it is small,[62] and because it remains a constant with a given alloy. Thermal widening likewise causes no trouble, for although it varies in amount with different materials it may be assumed constant for any one material at a given temperature. The effect on line width of inhomogeneity in composition may be handled by thorough homogenization, or, in case this is inconvenient, by precautions to see that the inhomogeneous condition is retained unchanged throughout the experiment.

The most important point to be emphasized regarding the interpretation of line widening caused by internal stresses is that it is related directly to stresses of the microscopic type. Just as a macroscopic stress distribution leads to a shift of the diffraction lines—discussed under a subsequent heading—a microscopic distribution, where stresses vary in intensity in small regions of the specimen, causes a variable shift, therefore a widening. An equivalent statement frequently found in the literature is that widening reveals "lattice distortion." The relationship between line width and macroscopic stresses depends on the nature of the deformation.*

An extended mathematical treatment of the relation of line widening to lattice deformation has been given by Dehlinger.[63] He made the assumption that the deformation of a lattice is periodic and thus subject to the same type of analysis that is applicable to the theory of the optical grating containing periodic errors of ruling. The line widening phenomenon is not simply a broadening of an individual line, according to this view, but is caused by the blending together of a group of lines close to one another which are analogous to the ghosts accompanying the diffraction lines from an imperfect optical grating. Individually they cannot be seen; for, unlike the optical case, the period of the deformation is not constant. It was assumed, however, that conclusions from numerical calculations using some average amplitude and period would give a fair approximation to the actual case.

From his calculations on these assumptions Dehlinger concluded that a small deformation extending over a whole grain should give a widening of the order of magnitude observed (in a numerical example it was computed as ½°, compared with the 1° doublet separation of $CuK\alpha$ reflected from the (333) plane of Ag). On the other hand, an intense deformation over a small portion of a grain should give inappreciable widening, even though it is the seat of a relatively large amount of energy. Dehlinger suggested that metals which show strain widening of lines may have lattice distortion of the former type, while those which do not exhibit strain widening may have the latter type. This proposal was advanced to explain the early observations that aluminum produced no wider lines when cold worked than when annealed. It has recently been found, however,[64] that aluminum which is cold worked at −75° C. and photographed within a few hours does show widened lines. The lack of widening with aluminum under ordinary conditions may therefore be due to room temperature recovery from lattice distortion, rather than to a special type of deformation as proposed by Dehlinger. The same is undoubtedly true of lead and bismuth which certainly are self-annealing. Nevertheless, line widening has not been observed with drastic room temperature working of platinum, molybdenum and zinc, a fact that still requires explanation by Dehlinger's theory or otherwise.[65]

By means of measurement of line width and a simple compressibility formula, Caglioti and Sachs[56] have made an approximate calculation of the amount of elastic energy stored in the deformed lattice of cold worked copper. Their calculations of the elastic distortion energy gave 0.02 kg.-mm./mm.³ which was only 0.1% of the total work expended. A comparison of this figure with the measurements of Hort,[66] and of Farren and Taylor,[67] which showed the energy not appearing as heat and therefore residual in the lattice to be 2 to 15% of the energy expended, lead Caglioti and Sachs to the conclusion that the X-ray failed to detect much of the residual stress energy present in the lattice.

*Dr. Wm. L. Fink, who kindly read the proof of this review, tells me he has clearly seen the difference in line width (using Gerlach doublets) with strips pulled in tension compared with strips which were bent, the stresses in both cases being within the elastic range.

Widening with Plastic Deformation

Early observations by Davey and van Arkel on widening of lines by cold work have already been mentioned. Similar studies were made by Sekito on copper and steel,[68] and by Dehlinger[69] on silver, copper, tantalum, α-brass, aluminum and zinc. Wood has also investigated numerous metals.[70]

The manner in which microscopic stresses (as indicated by line widening) are built up with increasing amounts of deformation of various kinds has received extensive study. Dehlinger[69] compared the width of lines from silver sheets rolled to 5 and 50% reduction in thickness and found no difference in the width. Most experiments, however, have shown widths increasing with the severity of the deformation. Becker[71] noted that cold drawn tungsten single crystal wires gave wider diffraction lines at the surface of the wire than at interior points, exposed by etching, where deformation was probably less severe. Caglioti and Sachs[56] studied the increase in width with load for copper, using both single and polycrystalline rods in tension. After the elastic limit was exceeded, at approximately 10,000 lbs./in.² for the polycrystalline material and a much lower stress for the single crystal, they found a linear increase of the fractional change of interplaner distance $\frac{\Delta a}{a}$ with load (Fig. 18).

Wood[72] investigated the question with cold drawn wires and concluded that the breadth increases progressively with increasing reduction by drawing until it reaches a definite maximum which is characteristic of the metal. He noted that this maximum is reached before the reorienting of grains into a fiber structure begins, and suggested that the following was the order of events: 1. lattice distortion, producing increased line width, 2. slip, 3. reorientation as a result of slip, producing fiber structure.

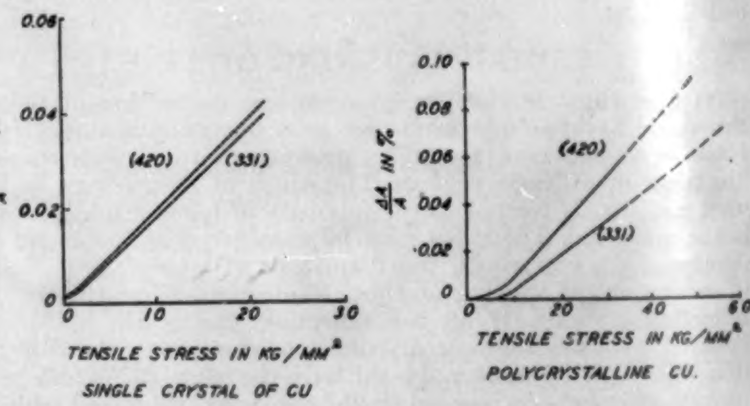


Fig. 18a and b. Line widths as a function of % elongation in tension (Caglioti and Sachs)

With mild steel originally stress-free, Regler[73] reports a linear increase of width with applied stress from the yield point up to a characteristic width at the breaking point. Plotting width against deformation (in his case the deflection of a bent strip in mm.) he obtained a curve which rounded off to a flat maximum. On the contrary, a similar curve for steel which had been previously work hardened differed from the curve for stress-free steel in that it was not linear but was concave upwards. Examples of increase in width with deformation have recently been published by Wever and Pfarr[74] for room temperature elongation and rolling of mild steel (Fig. 19).

Dehlinger[75] concluded the nature of the deformation was of utmost importance in determining the amount of line widening produced. His conclusions were supported by the following experiment. A sheet of silver which had been previously recrystallized was broken in a tensile testing machine, and the high angle diffraction lines were found to be sharp in spite of a reduction in area estimated to be about 20%. Yet the same specimen gave widened lines when rolled only 10%. He interpreted this to mean that rolling produces a large amount of bend-

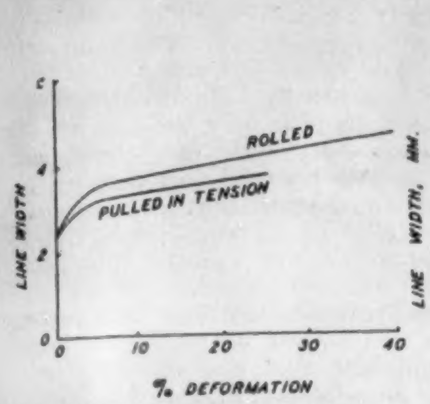


Fig. 19. Comparison of effect of rolling and straight elongation on line widths. (Wever and Pfarr)

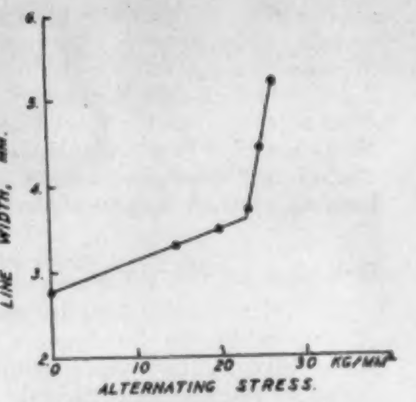


Fig. 20. Line widening from fatigue. (Regler)

gliding and leaves the material with highly stressed glide-lamellae, while simple elongation allows slip to take place with less restraint and thus less bending of lamellae.**

Widening with Elastic Deformation

It is not certain that elastic stressing of a metal can cause measurable widening of lines, for neither Sachs and Weerts nor Wever and Pfarr have found a measurable increase in line width when duralumin, brass, or steel is stressed within the elastic limit.[74] On the contrary, Regler[73] claims the widening within the elastic range is so considerable that measurement of it makes possible a determination of stress to ± 0.1 kg./mm². (142 lbs./in².) but as he gives no experimental data in support of this statement, and as his experimental technique is usually inferior to that of the Germans, his claim carries little weight at present.

Effect of Fatigue on Line Width

Dehlinger[76] has noted that the diffraction lines from cold rolled copper and silver sheets were wider than lines from the same materials at the surfaces of breaks, provided the fractures occurred as the result of repeated bending back and forth. Pfarr[74, 77] has published back reflection photograms of hardened steel before and after 4 million reversals of load (stress amplitude not given) which show a remarkable transition from a broad halo before loading to a distinct diffraction line after fatiguing. Very recently H. A. Smith* has observed lines from the surface of fatigue breaks in aluminum wires to be sharper than lines from the normal portion of the wires. Regler,[73] on the other hand, found quite the opposite effect, an increased width from fatigue. He measured radial widening on a steel fatigue test piece under various loads after 10 million reversals at each load and found the result given in Fig. 20, indicating a sort of endurance limit at 28,000 lbs./in.² and a final width, at fracture, equalling the width from a break in simple tension.†

Sufficient data are lacking to draw any safe conclusions in this field. It should prove a fruitful field for future investigators. Perhaps it will be found that the observations mentioned above are actually not contradictory at all, and that the fatigue process *increases* the width of lines from previously *unstressed* material up to a definite value, yet *decreases* the width of lines from previously *stressed* material to a definite value—perhaps to the same ultimate value in both cases. At least one fact is certain, that repeated stressing does alter the state of internal stress in some manner, for this is shown not only by the X-ray observations just mentioned, but also by stress-strain curves before and after cyclic stressing,[78] and less directly by magnetic measurements, by resistance measurements,[79] and by other means. It is also to be inferred from the occurrence of slip lines during cyclic stressing, so clearly demonstrated by Gough, as well as by the appearance of asterism in fatigued specimens.[65]

It seems clear that isolated X-ray experiments on fatigue, such as the pioneer X-ray experiments just mentioned, should now be followed by systematic and carefully planned research. The successful research of the future in the application of X-rays to fatigue problems will doubtless be done by those thoroughly familiar with the fatigue side of the problem—especially the relation of internal stress to fatigue—for the greatest complexities lie on the fatigue side, not on the X-ray side.

Preferential Widening of Lines

It will be seen from Caglioti and Sachs' curves reproduced in Fig. 18 that the (420) and (331) lines did not widen equally when a copper rod was elongated. Wood[80] found a similar effect in a drawn wire of constantan: the (420) line became diffuse while the (331) remained relatively sharp. Contrary to the results of Caglioti and Sachs, however, he found that this differential effect disappeared at larger deformations. Sekito[68] studied the relative width of lines from cold drawn copper without very definite results. Dahl, Holm, and Masing[81] reported a preferential widening of lines accompanying precipitation from solid solution. An alloy of 2.5% Be in Cu was aged at 200° C. after quenching from 800° C.; all the lines of the solid solution became fuzzy but not equally so, the (111) line remaining sharper than the rest.

Regler[73] finds the (002) line not widened by static loading of steel, even at a broken surface, while all other lines increase markedly in width. On the other hand all of the lines, including the (002), are widened by the process of fatigue. The ratio of width of (002) to other lines such as (022) and (112) is proposed as a means of distinguishing between static and dynamic loads, and of separating the total load into its static and dynamic components. He ascribes preferential widening in steel to a reduction in symmetry from cubic to rhombohedral; Seljakow[31] also suggests that a reduction in symmetry is the basis for widening of Debye lines, but he considers that α-Fe becomes triclinic under stress and that NaCl becomes monoclinic.

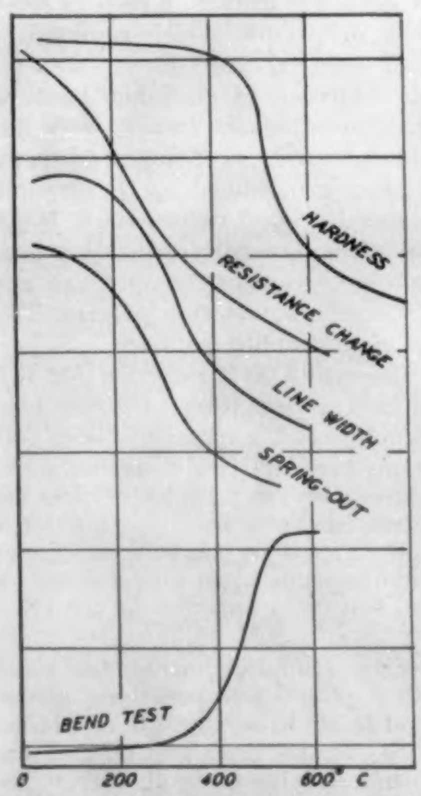


Fig. 21. Recovery in electrolytic iron plotted against annealing temperature. (Tammann)

Here again is a subject where but a few isolated results are available, and where future research might be profitable.

Line Width vs. Recovery and Recrystallization

That annealing has a profound effect on diffraction line widths of deformed metals has been recognized since the work of Davey and van Arkel in 1925. But it early became clear that

**An interesting application of this type of X-ray work was presented this winter before the *American Society of Mechanical Engineers* by L. Thomassen and D. M. McCutcheon. They studied the depth of metal which is disturbed by turning and milling, as a function of the depth of cut, rate of feed, cutting force, and sharpness of cutter, for two samples of brass. Their procedure was to make a series of photograms with molybdenum radiation falling on brass at a small angle of incidence producing a pattern with Gerlach doublets, and etching the sample between each photogram. The depth of cold working was indicated by the depth to which the sample had to be etched to produce lines of normal sharpness.

† The April 1934 *Metallwirtschaft* carries an article by P. Ludwik and R. Scheu (pages 257-261), also of Vienna, who vigorously disagree with some of Regler's contentions. They find the line width from a fractured surface to depend on the type of loading, being smaller at fatigue breaks than at tension breaks, and to depend on the thermal history of the metal. The distribution of stresses causing the break is another important factor; since the same material may undergo a brittle fracture when broken under three-dimensional stress and a ductile fracture when broken in uniaxial tension, the amount of deformation at the break—and the line width—cannot be characteristic of the material, as Regler thinks. While Ludwik and Scheu have disproved Regler's claim of a characteristic line width at fracture and have found his technique of measurement quite inaccurate, they have not disproved his claim that line width undergoes a progressive change during fatigue, for they X-rayed the specimens only after they were broken.

recrystallization was not always necessary to produce a sharpening of lines, and that a different phenomenon, "recovery," could accomplish this. Studies by Koref,[82] Becker,[58] Göler and Sachs,[83] Goucher,[49] van Arkel and Burgers,[57] and others clearly demonstrated that recovery in tungsten takes place between 600° and 1500° C. (depending on the purity), while in each case recrystallization occurs at higher temperature (800° to 2000° C.), the gap between the threshold temperatures for the two processes sometimes being as much as 1000° C. There are no changes in appearance under the microscope accompanying this recovery.

Tammann has shown in an extensive series of studies in the *Annalen der Physik and Zeitschrift für anorganische Chemie*[84] that different physical properties may undergo recovery at different temperatures. Referring to Tammann's recovery curves in iron, Fig. 21, the line-width curve follows rather closely the curve for amount of springing-out of a wire previously wrapped around a mandrel and annealed in the wrapped position, indicating a recovery of the microscopic stresses (causing line width) at the same temperature as the macroscopic stresses (causing a straightening of the wire). On the contrary, line width does not seem to be correlated so closely with electrical resistance or with hardness. In fact curves for many different properties of Fe, Ni, Pt, and Pd show the beginning of recovery at different temperatures, but with Cu, Ag, and Au recovery begins at the same temperature for all the properties studied. Comparative line width studies of this type have been made only on iron and steel and on tungsten.

The sharpening of lines from strain hardened electrolytic iron by annealing has lately been studied by Wever and Pfarr,[74] who have shown that there is a rapid decrease in width brought about by ½ hour annealing in the range 400° to 500° C. Photomicrographs of the samples show recrystallization beginning at 450° C. at the surface of the rolled sample where the deformation was greatest. They concluded that line width for electrolytic iron is decreased most by recrystallization, but appreciably also by recovery taking place below 450°.

The breadth of lines in X-ray photograms can be used as a control of stress-relief annealing. There is need for caution in such uses, however, for in the usual arrangement only the surface material contributes to the photogram, and this material may not be representative of the whole cross section. A surface more drastically worked than the interior may recrystallize and become stress-free far more rapidly than the interior; thus line widths in surface reflection photograms may decrease more rapidly than other indications of lattice distortion such as hardness, conductivity, and tensile properties, which represent a more average value throughout the cross section.

An anomalous case of line widening in steel has been reported[74] in which increasing deformation led to *decreased* line width. The deformation in this case was at elevated temperatures, so the peculiar result may be explained by the dependence of recrystallization temperature upon deformation. When deformation reached a certain value, the recrystallization temperature was lowered to the temperature of the specimen and the lines were sharpened by the recrystallization process. This conclusion was confirmed by micrographic evidence.

Wever and Pfarr propose line width as a criterion for differentiating between hot and cold deformation: if X-ray photograms of a metal show widened lines the metal has been cold worked, while if the photograms show narrow lines the metal has been hot worked and recovery or recrystallization has occurred. It is possible, of course, to have some portions of a rolled sheet hot rolled while other portions are cold rolled, for the velocity of recrystallization depends upon the severity of deformation, and this, in turn, may vary throughout the cross section of the sheet.

Berthold[85] has made a practical application of line-width determinations by investigating with back reflection photograms a turbine shaft which had failed in service. He concluded from the variation in line width over the cross section that the shaft had received a non-uniform treatment in the stress relieving anneal. Samples were cut from the object, annealed at 400° C., and it was found that the lines became sharper, thus indicating that some portions of the shaft had not been held a sufficient time at 400° to relieve stresses. He emphasized the point that it is not always advantageous to demand sharp lines from steel, for sometimes the material is in its best condition when lines are broad; line widening can occur without deleterious effect on physical properties, and a thorough knowledge of the characteristics of the material is necessary in interpreting line widening data.

Recrystallization reveals itself on Debye photograms by the appearance of individual spots replacing continuous rings, owing to the growth of stress-free grains. Glocker, Kaup and Widman[86] were among the first to notice this, using silver foil. As to whether this X-ray test is as sensitive an indicator of recrystallization as the microscope, there is only the evidence of Wever and Pfarr's studies[74] on electrolytic iron; they concluded that recrystallization in this material was detected in both ways with approximately equal sensitivity.

Relation to Hardness

There has been a lengthy controversy regarding the relation of line width to hardness which should be mentioned here. Some investigators have maintained that line widening produced by cold work is directly correlated with work hardening, while others have insisted that no such relation exists.[87] Göler and Sachs[83] made the significant observation that recovery could take place in cold worked tungsten at about 900° C. with complete removal of the line widening yet without appreciable reduction in tensile strength, from which they concluded that the widening from cold deformation had nothing to do with work hardening. Dehlinger[75] reached the same conclusion from the fact that different types of deformation produce varying degrees of line widening, whereas strain hardening has been shown to follow about the same curve when plotted against reduction in area either by rolling, drawing through a die, or elongation in a tensile machine.[28] Fink and Van Horn[88], as well as Crampton[15], have likewise concluded that no necessary relation exists between lattice distortion as revealed by diffraction line width, and hardness—at least Rockwell hardness.

Wever and Pfarr[74], found that line-width variations paralleled hardness variations in iron provided the hardness was measured in the same thin layer that contributes to the diffraction photogram, and concluded that investigators had frequently been misled by comparing X-ray data from the surface material with hardness measurements representing the average condition throughout a considerable depth.

The situation as it stands today is still none too clear. The fact that there are some metals that can be work hardened without increase in diffraction line width seems rather conclusively to rule out microscopic stresses as a *cause* of hardening, though these stresses do seem to be *associated* with hardening in most metals.[65]

Summary

The radial widening of lines in powder diffraction patterns has received much study, both theoretically and experimentally. It is related directly to internal stresses of the microscopic type. Just as a macroscopic stress distribution leads to a shift of diffraction lines, a microscopic distribution, with stresses varying in intensity throughout small regions of the specimen, produces a varying shift of lines and consequently widens them. The relation between width of lines, type of deformation and amount of deformation is still somewhat obscure, as is our knowledge of the effect of fatigue on line width (where different observers have obtained apparently contradictory results). Crystal recovery sharpens lines; recrystallization and grain growth give them a spotty character. The relation of line width to hardness is controversial.

Bibliography

[49] F. S. Goucher. *Philosophical Magazine*, Vol. 2, 1926, page 289.

[50] F. Regler. *Mitteilungen des technischen Versuchsamtes*, Vol. 20, 1931, page 43; Vol. 21, 1932, page 31; *Physikalische Zeitschrift*, Vol. 33, 1932, page 435; *Ergebnisse der technischen Röntgenkunde*, Leipzig, Vol. 3, 1933, pages 183-193.

[51] F. Regler & A. Pohl. Berichte der 2 ten Internationalen Schrenentagung, Verband für die Materialprufung der Technik, Zurich, March 1933.

F. Regler. *Mitteilungen des technischen Versuchsamtes*, Vol. 21, 1932, pages 31-46.

[52] Fell. *Iron & Steel Institute, Carnegie Scholarship Memoirs*, Vol. 16, 1927, page 101.

[53] H. S. Rawdon. *Bureau of Standards Journal of Research*, Vol. 1, 1928, page 467.

[54] W. P. Davey. *General Electric Review*, Vol. 28, 1925, page 588.

[55] A. E. van Arkel. *Physica*, Vol. 5, 1925, page 208.

[56] V. Caglioti & G. Sachs. *Zeitschrift für Physik*, Vol. 74, 1932, page 647.

F. Wever & B. Pfarr. *Mitteilungen Kaiser Wilhelm Institut für Eisenforschung*, Vol. 15, 1933, page 137.

✓✓ [57] van Arkel & Burgers. *Zeitschrift für Physik*, Vol. 48, 1928, page 690.

[58] K. Becker. *Zeitschrift für Physik*, Vol. 42, 1927, page 226-245.

[59] U. Dehlinger. *Zeitschrift für Metallkunde*, Vol. 23, 1931, page 147.

[60] W. A. Wood. *Nature*, Vol. 129, 1932, page 761.

[61] W. A. Wood. *Philosophical Magazine*, Vol. 99, 1933, pages 553-562.

[62] F. Wever & H. Möller. *Mitteilungen Kaiser Wilhelm Institut für Eisenforschung*, Vol. 15, 1933, page 59.

[63]U. Dehlinger. *Zeitschrift für Kristallographie,* Vol. 65, 1927, page 616.

[64]L. Thomasson & J. E. Wilson. *Physical Review,* Vol. 43, 1933, page 563.

[65]H. J. Gough. *Proceedings American Society for Testing Materials,* Vol. 33, Pt. II, 1933, Marburg Lecture.

[66]W. Hort. *Zeitschrift Verein deutscher Ingenieure,* Vol. 45, 1906, pages 1831-1837.

[67]W. S. Farren & C. J. Taylor. *Proceedings Royal Society,* London, Series A, Vol. 107, 1925, pages 422-451.

[68]S. Sekito. Science Reports Tohoku Imperial University, Vol. 16, 1927, page 343; *Zeitschrift für Kristallographie,* Vol. 67, 1928, page 285.

[69]U. Dehlinger. *Zeitschrift für Kristallographie,* Vol. 67, 1928, page 285.

[70]W. A. Wood, *Philosophical Magazine,* Vol. 11, 1931, page 610; Vol. 13, 1932, page 355; Vol. 14, 1932, page 656; Vol. 15, 1933, page 553; *Proceedings Physical Society, London,* Vol. 44, 1932, page 67.

[71]Becker. *Zeitschrift für Physik,* Vol. 58, 1929, page 11.

[72]W. A. Wood. *Philosophical Magazine,* Vol. 14, 1932, page 656; Vol. 15. 1933, pages 553-562; *Proceedings Physical Society,* Vol. 44, 1932, page 67; *Nature,* Vol. 129, 1932, pages 760-761.

[73]F. Regler. *Mitteilungen der Technischen Versuchsamtes,* Vol. 21, Vienna, 1932.

[74]F. Wever & B. Pfarr. *Mitteilungen Kaiser Wilhelm Institut für Eisenforschung,* Vol. 15, 1933, page 137. F. Wever. *Stahl und Eisen,* Vol. 53, 1933, page 497.

G. Sachs & J. Weerts. *Zeitschrift für Physik,* Vol. 64, 1930, page 344.

[75]U. Dehlinger. *Annalen der Physik,* (5) Vol. 2, 1929, pages 749-793.

[76]U. Dehlinger. *Naturwissenschaften,* Vol. 17, 1929, page 545.

[77]B. Pfarr. *Zeitschrift für technische Physik,* Vol. 14, 1933, page 220.

*As yet unpublished.

[78]F. C. Lea. *Engineering,* Vol. 115, 1923, page 252. See also references to magnetic methods given in the third section under "Mechanical Methods of Analysis."

[79]H. F. Moore & S. Konzo. *Bulletin No.* 205, *Eng. Experiment Station, University of Illinois.*

[80]W. A. Wood. *Nature,* Vol. 129, 1932, page 761.

[81]O. Dahl, E. Holm & G. Masing. *Zeitschrift für Metallkunde,* Vol. 20, 1928, page 431.

[82]F. Koref. *Zeitschrift für Metallkunde,* Vol. 17, 1925, page 217.

[83]F. v. Göler & G. Sachs. *Zeitschrift für Metallkunde,* Vol. 19, 1927, page 410.

[84]For a summary and bibliography see "Die Heraeus-Vacuumschmelze," Hanau am Main, 1933, pages 86-108.

[85]Prüfungsberichte der Allianz und Stuttgart. Vereins Heft 1. Jan. 1933; see F. Wever. *Stahl und Eisen,* Vol. 53, 1933, page 497.

[86]Glocker, Kaup & Widman, *Zeitschrift für Metallkunde,* Vol. 17, 1925, page 353.

[87]Van Arkel. *Physica,* Vol. 5, 1925, pages 208-212.

Goucher. *Philosophical Magazine,* (7) Vol. 2, 1926, pages 289-309.

Becker. *Zeitschrift für Physik,* Vol. 42, 1927, pages 226-245; Vol. 47, 1928, page 454.

[88]Fink & van Horn. *Journal Institute of Metals,* Vol. 44, No. 2, 1930, page 241.

A.F.A. Nominating Committee Reports

The 1934 A.F.A. Nominating Committee has certified that the following members were nominated for officers and directors: President, D. M. Avey, Editor, "The Foundry," Cleveland; Vice-President, B. H. Johnson, Assistant to the President, R. D. Wood & Co., Philadelphia, Pa.; Directors: Frank J. Lanahan, President, Fort Pitt Malleable Iron Co., Pittsburgh, Pa.; A. E. Harrison, General Supt. of Foundries and Pattern Shop, Allis-Chalmers Mfg. Co., Milwaukee, Wis.; E. W. Campion, Assistant Supt., Buckeye Steel Castings Co., Columbus, Ohio; Sam Tour, President, Lucius Pitkin, Inc., New York; E. O. Beardsley, President, Beardsley & Piper Co., Chicago.

C. W. Piper, 2033 Maple Ave., Norwood, Ohio, has been appointed as sales representative for the Southern Ohio and Eastern Indiana territory covering "FALCON" furnaces manufactured by H. O. Swoboda, Inc., Pittsburgh, Pa.

The Sivyer Steel Casting Company, Milwaukee, Wisconsin, has announced the opening of a new New York office in charge of A. N. Diecks, 500 Fifth Avenue, New York.

The International Nickel Company are installing a new 15/20 ton top charge direct arc basic Lectromelt furnace to replace a door charge type furnace.

The Duriron Company, of Dayton, Ohio, has started construction of an extension to their alloy steel foundry which just doubles the size of the present plant. Construction work is being pushed ahead as rapidly as possible and the new equipment will be installed as soon as the extension is under cover. Additional electric induction furnaces will be installed.

METALLURGICAL RESEARCH

(Continued from page 166)

It is surprising how frequently vital points are omitted from research reports. Sometimes, minute details are left out of the description of a process, an omission which renders the process useless to another person. The writer has in mind the troubles of an organic chemist of his acquaintance, who arrived at the conclusion that it was quite impossible to prepare a certain compound by a certain method. He had faithfully followed the description of this method, as given in a certain paper, but without success. He decided that the writer of the paper must have been in error in stating that his method would bring about the result described. A letter to the writer of the paper brought forth the fact that a very minor detail—one which he had felt need not be mentioned—had been left out of the description. The chemist's next attempts to reproduce results were entirely successful.

We are leaving the main point we are trying to make—the necessity for following up work that is being done in the plant. In this connection, another story may be of interest. The writer was asked to draw up specifications for the control of furnaces and for the pouring technique to be used in the manufacture of copper castings. The furnaces in use in the plant were of the oil-fired, open-flame, barrel type. After considerable experiment in the foundry, the conditions best suited for the production of sound castings were determined, and specifications based upon the numerous experiments that had been conducted were drawn up. From time to time the writer had opportunity to visit the foundry. No complaints were heard from the management. About a year after the specifications had been approved and accepted, the writer happened to be walking through the foundry and noticed that alterations were being made to one of the furnaces. On inquiry, he discovered that the management had decided to change from oil to gas in this particular furnace. The writer pointed out that conditions existing in such a furnace when gas-fired would be somewhat different from those existing in the same furnace when oil-fired and suggested that new specifications might have to be drawn up in the event that the design of all the furnaces was changed. The idea did not sink home. Six or more weeks passed before one day an S.O.S. was received by the writer, begging him to come down and explain why such excessive quantities of deoxidizer were being needed to counteract unsoundness in the castings being produced. The writer sometimes blames himself for not having stayed on the job right at the time that the furnaces were being changed; but, like other men, the metallurgist sometimes feels that if hints are not taken, hurts alone will teach the needed lesson. Be that as it may, this story serves to emphasize the responsibility which the research worker has to the plant for following up the work which he has been called upon to do.

Carl Riefkin, formerly advertising manager of the Andrews Steel Company, has been made Assistant General Sales Manager. John Dulwebber succeeds Mr. Riefkin as Advertising Manager.

The Brown Instrument Company, Philadelphia, Pa., announces the appointment of **L. Morton Morley** as General Sales Manager. Mr. Morley, former District Manager of the Philadelphia office, has been associated with the Brown Instrument Company for the past 15 years.

THE PROPERTIES OF ALUMINUM and Two of its Alloys AT ELEVATED TEMPERATURES

By F. M. HOWELL* and D. A. PAUL*

PREPARATORY to a study of the creep of aluminum and the various aluminum alloys at elevated temperatures, a method of test has been devised at the Aluminum Research Laboratories by which the stability of each material at the different temperatures is determined. In making either tensile or creep tests at elevated temperatures, many investigators have neglected the fact that under such conditions structural changes take place in materials that have a pronounced effect on their mechanical properties. At temperatures slightly above normal these changes may not be very marked but they may occur over long periods of time. At higher temperatures, approaching the recrystallization range of the material, the stable condition may be attained after relatively short periods.

In this investigation, which was carried out in the Aluminum Research Laboratories under the direction of Mr. R. L. Templin, Chief Engineer of Tests, Aluminum Company of America, the effects of prolonged heating at different temperatures on the mechanical properties of the materials both at normal and elevated temperatures were determined. The tensile property values determined at elevated temperatures by the methods described herein are of more significance than those determined by means of the short-time test.

Materials

The materials tested in this investigation are designated as 2S (commercially pure aluminum), 3S (commercially pure aluminum + 1.25% manganese), and 4S (commercially pure aluminum + 1.25% manganese and 1.0% magnesium). These materials are not susceptible to strengthening by means of heat treating, but their tensile strength, yield strength, and hardness may be increased by cold working. In this investigation tests were made on the materials in both the annealed and cold-worked conditions. The following is the nomenclature used throughout the paper to indicate the temper of the material:

2S-O—2S material in the annealed state.
2S-H—2S material in the commercial hard-drawn or rolled state (approximately 80% reduction).
2S-1/2H—2S material which has received such an amount of cold working after having been annealed as to raise the tensile strength to a point midway between those of the annealed and full-hard tempers.

These designations also apply to 3S and 4S.

The chemical compositions of these materials are given in Table 1.

Table 1. Chemical Analyses of Materials

Material	Silicon, %	Iron, %	Copper, %	Manganese, %	Magnesium, %	Aluminum, % (by diff.)
2S-O & 2S-H...	0.13	0.53	0.11	0.02	...	99.21
2S-1/2H	0.11	0.66	0.04	0.01	...	99.18
3S-O & 3S-H...	0.22	0.45	0.10	1.20	...	98.03
3S-1/2H	0.37	0.48	0.11	1.22	...	97.82
4S-O, 4S-1/2H & 4S-H	0.20	0.30	0.05	1.22	1.04	97.19

Test Procedure

The following test procedure is employed in making the long-time tests at elevated temperatures: From 10 to 20 specimens of one material are placed in a furnace operating at a constant temperature. A specimen is then removed from this furnace after a definite interval of time, quickly transferred to the furnace in which it is to be tested and, after temperature conditions have again reached equilibrium, the specimen is pulled. Tests are made at intervals in this manner until the material shows no further change of strength with increased exposure to temperature. For the materials tested in this investigation heating periods ranging from about 20 days to 650 days, depending upon the temperature, were used to obtain final tensile and yield strength values. The tests were made at 212°, 300°, 400°, 500°, 600° and 700° F.

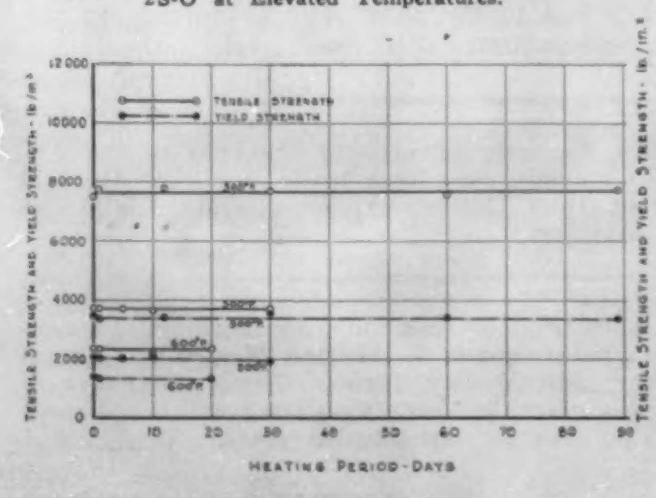
In addition to the tests described above, tensile and hardness tests were made at room temperature on specimens that had been heated for prolonged periods at elevated temperatures. These tests were made to show the softening at room temperature which results from exposure of the materials to elevated temperatures for long periods of time.

Discussion of Results

1. Effects of Prolonged Heating at Elevated Temperatures on Tensile Properties at Elevated Temperatures.

The tensile strength and yield strength data obtained on 2S-0, 2S-½H, and 2S-H at elevated temperatures have been plotted against heating time at temperatures in Figs. 1 to

Fig. 1. Tensile Strength and Yield Strength of 2S-O at Elevated Temperatures.



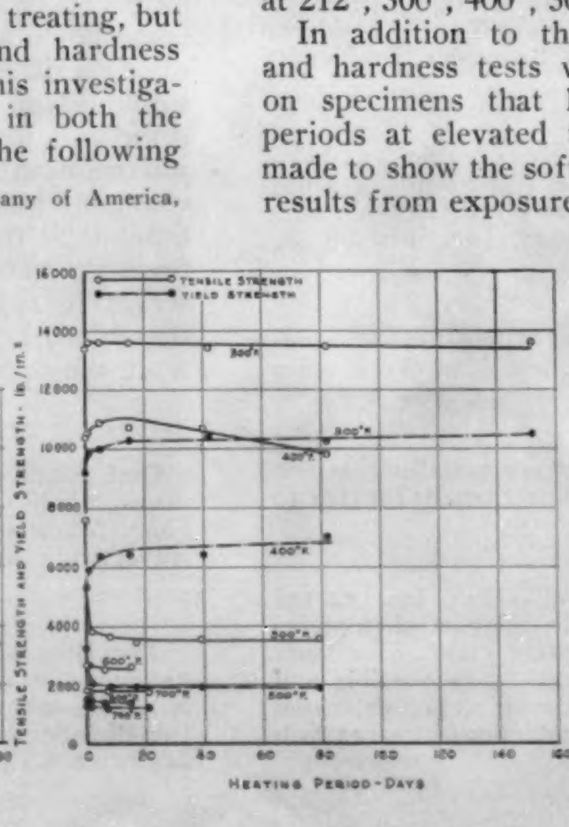


Fig. 2. Tensile Strength and Yield Strength of 2S-1/2H at Elevated Temperatures.

* Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa.

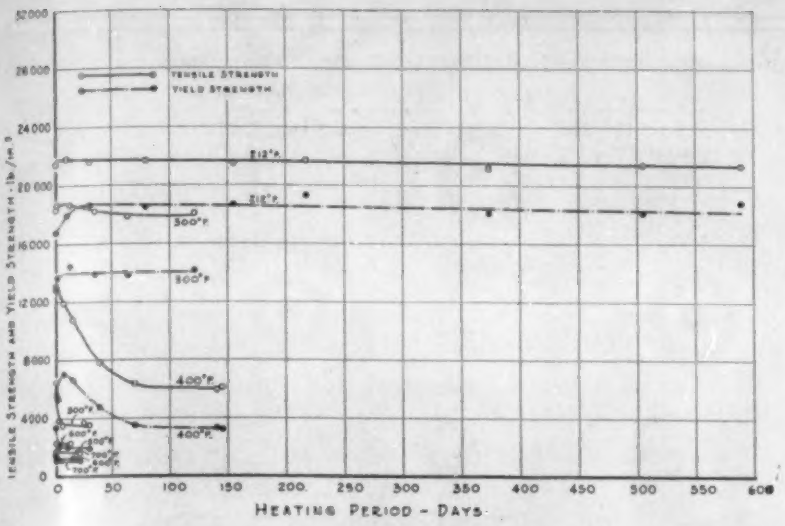


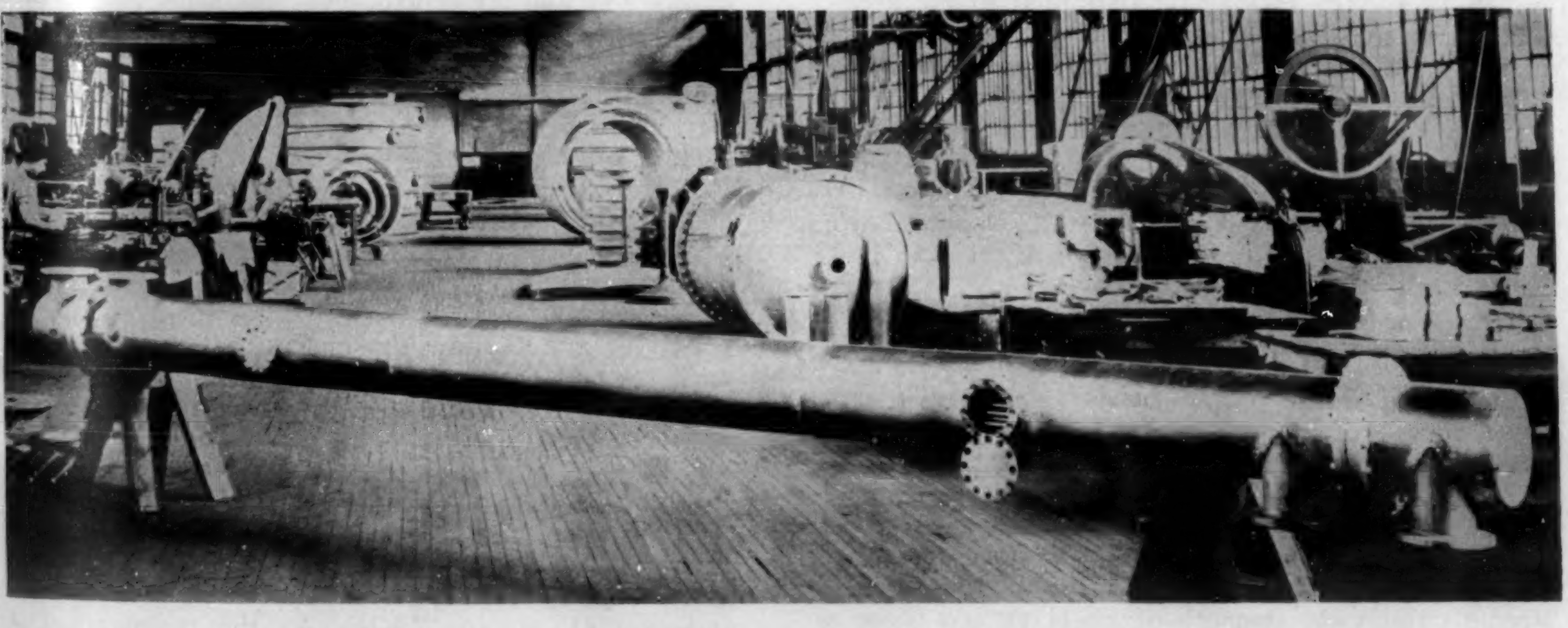
Fig. 3. Tensile Strength and Yield Strength of 2S-H at Elevated Temperatures.

3. The first point on each of these curves represents the value obtained after a heating period of about 1 hour (short-time value), while the final horizontal portion of the curve is indicative of the long-time value. The corresponding curves for 3S and 4S are very similar to the above, hence they are not included.

Prolonged heating at the testing temperature did not produce any appreciable change in the strength of 2S-0 (Fig. 1) as this material was fully annealed prior to test.

Although prolonged heating at 300° and 400° F. had little effect on the tensile strength of 2S-½H at these temperatures (Fig. 2), it increased the short-time yield strength at both temperatures over 20%. At 300° F. this increase of yield strength occurred within the first 15 days, and at 400° F. within 5 days. The increase in yield strength can probably be attributed to relief of internal strain. At 500° F. the tensile strength of 2S-½H decreased about one-half when the heating period was increased from one hour to one day, and then showed only a slight change for heating periods up to 80 days. At 600° and 700° F. the one-hour heating period was sufficient to anneal the 2S-½H and, consequently, the tensile strength and yield strength changed only slightly with prolonged heating at these temperatures.

The behavior of 2S-H material (Fig. 3) when heated at elevated temperatures is different from that of 2S-½H. The 2S-H was tested at 212° F. and at this temperature the changes noted are similar to those noted for 2S-½H at 300° F.; the tensile strength remains about the same and the yield strength increases through relief of internal strain. At 300° F. the tensile strength of 2S-H decreased slightly while the yield strength appeared to remain unchanged. At 400° F. the tensile strength and yield strength of 2S-H decrease rapidly with prolonged heating, whereas in the case of 2S-½H the yield strength values at 400° F. increased as longer heating periods were used.



Multitubular Heat Exchange Unit of Aluminum Alloys

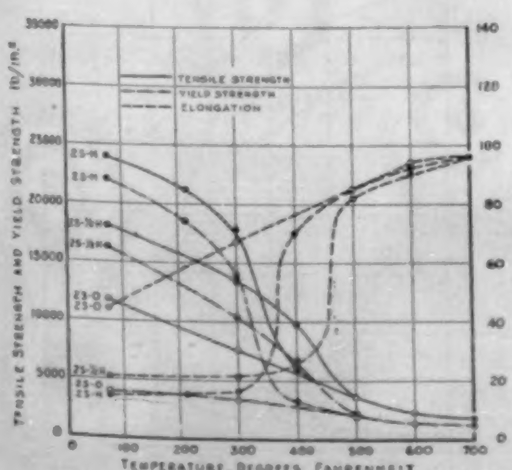


Fig. 4. Tensile Properties of 2S at Various Temperatures.

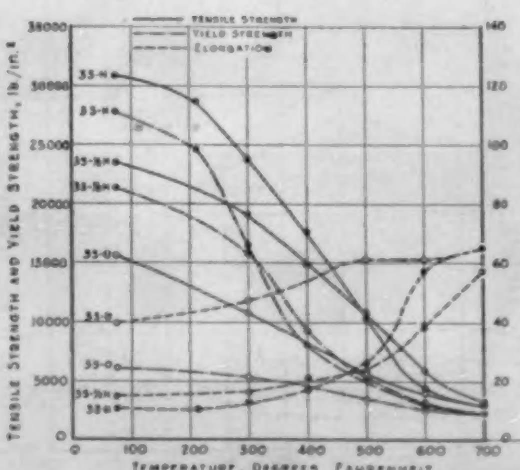


Fig. 5. Tensile Properties of 3S at Various Temperatures.

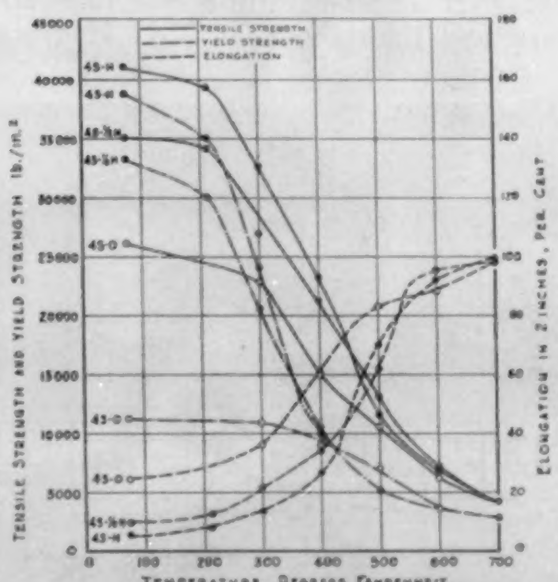


Fig. 6. Tensile Properties of 4S at Various Temperatures.

Table 2. Tensile Properties of Materials at Different Temperatures after Prolonged Heating at Testing Temperature

Material	Property	Temperature, °F. 75	212	300	400	500	600	700
2S-O	Tensile Strength, lbs./in.²	11,800	.....	7,600	.....	3,650	2,300	.....
	Yield Strength (Set = 0.2%), lbs./in.²	3,900	.....	3,400	.....	1,950	1,350	.....
	Elongation in 2 in., %	44	.....	67	.....	85	94	.....
	Reduction of Area, %	84	.....	92	.....	97	99	.....
2S-1/2H	Tensile Strength, lbs./in.²	18,000	.....	13,400	9,800	3,500	2,600	1,800
	Yield Strength (Set = 0.2%), lbs./in.²	16,250	.....	10,400	6,800	1,900	1,400	1,200
	Elongation in 2 in., %	21	.....	22	25	82	90	84
	Reduction of Area, %	74	.....	82	89	98	99	98
2S-H	Tensile Strength, lbs./in.²	24,000	21,200	17,800	6,000	3,500	2,250	1,700
	Yield Strength (Set = 0.2%), lbs./in.²	22,000	18,500	14,000	3,200	1,900	1,300	1,100
	Elongation in 2 in., %	15	15	16	70	85	92	96
	Reduction of Area, %	60	63	69	94	97	99	99
3S-O	Tensile Strength, lbs./in.²	15,600	.....	10,700	.....	5,600	3,900	.....
	Yield Strength (Set = 0.2%), lbs./in.²	6,100	.....	5,300	.....	3,400	2,500	.....
	Elongation in 2 in., %	40	.....	47	.....	61	61	.....
	Reduction of Area, %	73	.....	76	.....	85	85	.....
3S-1/2H	Tensile Strength, lbs./in.²	23,500	.....	19,000	14,800	10,800	5,800	3,200
	Yield Strength (Set = 0.2%), lbs./in.²	21,300	.....	15,300	9,200	5,200	3,100	2,200
	Elongation in 2 in., %	15	.....	16	21	23	38	57
	Reduction of Area, %	56	.....	62	70	74	84	87
3S-H	Tensile Strength, lbs./in.²	30,800	28,600	23,700	17,600	10,500	4,300	2,950
	Yield Strength (Set = 0.2%), lbs./in.²	27,750	24,600	16,400	8,000	5,100	2,850	2,200
	Elongation in 2 in., %	11	10	13	17	26	57	65
	Reduction of Area, %	44	44	50	62	73	77	81
4S-O	Tensile Strength, lbs./in.²	26,200	.....	22,800	14,900	10,500	6,200	.....
	Yield Strength (Set = 0.2%), lbs./in.²	11,250	.....	10,900	9,000	7,000	3,600	.....
	Elongation in 2 in., %	25	.....	36	61	83	88	.....
	Reduction of Area, %	55	.....	60	75	83	82	.....
4S-1/2H	Tensile Strength, lbs./in.²	35,100	34,100	26,900	21,250	13,100	7,100	4,200
	Yield Strength (Set = 0.2%), lbs./in.²	33,250	30,000	20,500	10,500	5,100	3,650	2,800
	Elongation in 2 in., %	10	13	22	34	62	95	98
	Reduction of Area, %	43	43	58	68	84	89	81
4S-H	Tensile Strength, lbs./in.²	41,000	39,300	32,600	23,200	11,600	6,750	4,000
	Yield Strength (Set = 0.2%), lbs./in.²	38,750	35,000	24,000	9,900	5,000	3,500	2,400
	Elongation in 2 in., %	6	8	14	27	70	92	99
	Reduction of Area, %	21	23	35	54	81	75	69

The difference in the effects of these temperatures on 2S-½ and 2S-H may be attributed to the greater amount of cold work present in 2S-H, which tends to make it more susceptible to the effects of comparatively low temperatures. The difference in the amount of cold work between the half-hard and full-hard tempers of 2S seems to make a difference of about 100° F. in annealing temperature. At 500°, 600° and 700° F. the behavior of 2S-H is about the same as that of 2S-½H.

2. Comparisons of Long-time Tensile Properties at Elevated Temperatures.

Long-time tensile property data have been selected from curves of the types just described and these have been plotted against testing temperature in Figs. 4, 5, and 6. These data are summarized in Table 2.

It is obvious from Fig. 4 that 2S-H does not retain its original tensile strength and yield strength as well as 2S-½H at elevated temperatures. The tensile strength and yield strength of 2S-H exceed those of 2S-½H at temperatures less than about 325° F., but are less than those of 2S-½H from 325° to about 500° F. The tensile strength and yield strength values of 2S-½H and 2S-H are about the same as the corresponding values for 2S-0 from 500° to 700° F.

The long-time elongation values for 2S in the tempers tested are also shown in Fig. 4. This property of 2S-0 increases in almost a straight line from a value of 44% at room temperature to 94% at 600° F. The elongation of 2S-H increases rapidly from 300° to 400° F., and at the latter temperature is almost equal to that of 2S-0. The elongation of 2S-½H increases rapidly from 400° to 500° F. and at 500° F. is about the same as that of 2S-0.

Figs. 5 and 6 show the long-time tensile strength, yield strength, and elongation values for 3S and 4S at different temperatures. The trends of the curves for these materials are similar to those of the curves for 2S, but it should be noted that the strength of strain-hardened 3S does not become equal to that of the originally annealed material until temperatures in the region of 600° F. are attained, whereas, in the case of 2S-½H, this condition was obtained at 500° and at 400° F. for 2S-H. As the temperature is

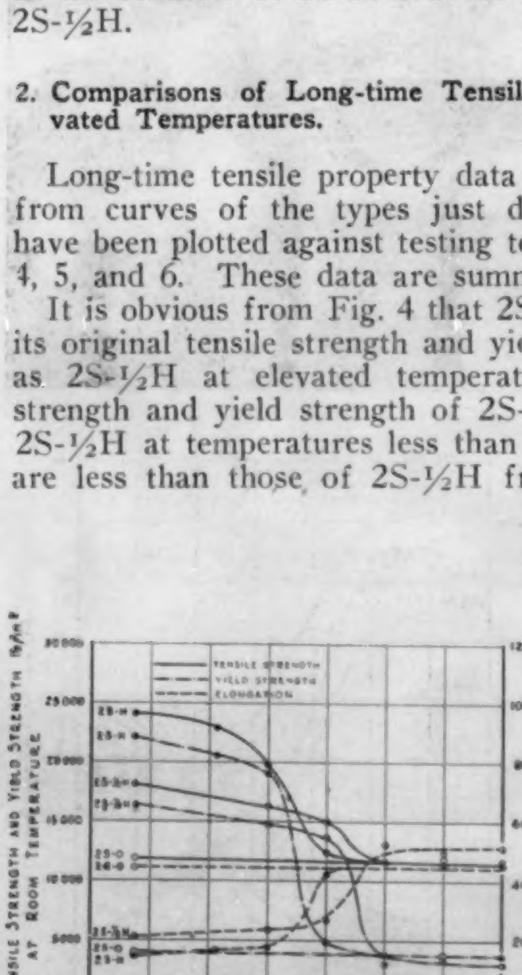


Fig. 7. Tensile Properties of 2S at Room Temperature after Prolonged Heating.

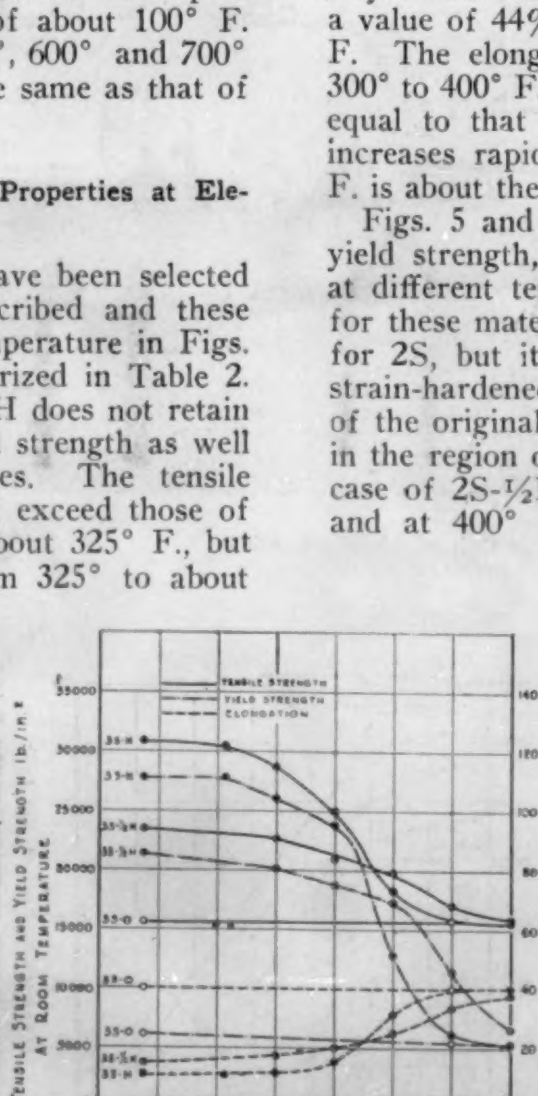


Fig. 8. Tensile Properties of 3S at Room Temperature after Prolonged Heating.

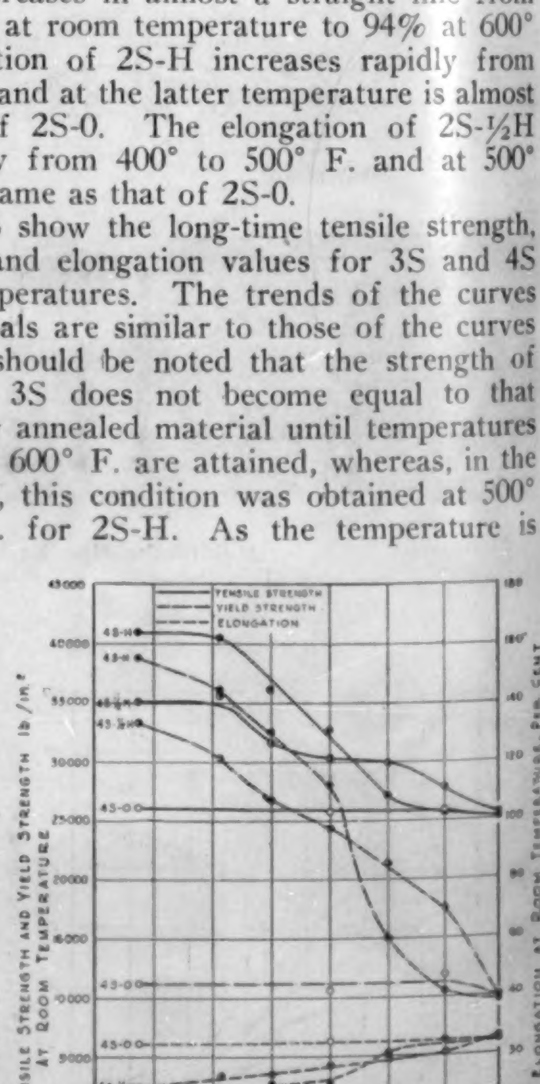


Fig. 9. Tensile Properties of 4S at Room Temperature after Prolonged Heating.

increased, 3S-½H and 4S-½H lose a smaller percentage of their original tensile strengths and yield strengths and at the higher temperatures their properties exceed those of the full-hard tempers. As in the case of 2S, the full-hard tempers of 3S and 4S appear to become completely annealed at a temperature approximately 100° F. less than the half-hard material.

3. Tests at Room Temperature on Specimens Heated for Prolonged Periods at Elevated Temperatures.

Figs. 7, 8, 9, and 10 show the results of tensile strength, yield strength, elongation and Brinell hardness determinations at room temperature on specimens heated at elevated temperatures for prolonged periods of time. It will be noted from these curves that the comparative properties of the materials at room temperature after prolonged heating are about the same as in the tests at elevated temperatures after prolonged heating.

These room temperature test results show that the hard tempers of 2S are not materiallv softened by prolonged exposure to temperatures in the region of 200° F. This is directly opposite to the findings published* by Zeerleder and Bourgeois. These authors

Table 3. Mechanical Properties of 2S-H at Room Temperature after Prolonged Heating at Elevated Temperatures

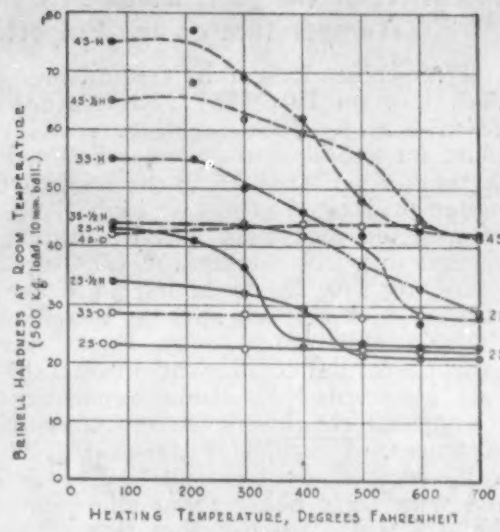
Heating Temperature, °F.	Heating Period, days	Tensile Strength, lbs./in.²	Yield Strength (Set = 0.2%), lbs./in.²	Elongation in 2 in., %	Reduction of Area, %	Brinell Hardness
75	...	24,000	22,000	15	60	43
212	652	22,800	20,500	16	62	41
300	139	19,700	19,000	17	68	36.5
400	146	12,330	4,800	42	80	24
500	30	11,500	3,750	46	83	23
600	17	12,100	3,500	45	83	23
700	22	11,900	3,650	45	82	23

did not tabulate specific data but made the statement that hard-drawn wires of aluminum were completely annealed if kept at 80° C. (176° F.) for 41 days (1000 hours). The results given in Table 3 show that a heating period of 652 days at 212° F. decreases the tensile strength and yield strength of 2S-H about 5% and 7%, respectively; also that 2S-H material is only partially softened by prolonged exposure to 300° F. The percentage decrease of the Brinell hardness of 2S-H is about the same as the percentage loss of tensile strength. The original hardness numeral of 43 drops to 41 after 652 days at 212° F., and to 36.5 after 139 days at 300° F. These values are considerably higher than the hardness numeral of 23 obtained on completely annealed material.

As shown by the curves plotted in Figs. 9 and 10, after prolonged heating at 212° and 300° F. the hard tempers of 3S and 4S have retained more of their original strength and hardness than 2S-H. A 260-day heating period at 300° F. decreases the tensile strength of 3S-½H from 23 500 to 22 500 lbs./in.² (4.2%) and the yield strength from 21 300 to 20 150 lbs./in.² (5.3%). A heating period of 149 days at 400° F. decreased the tensile strength and yield strength of 3S-½H only about 11%. In the cases of 3S-H, 4S-½H, and 4S-H the loss of strength caused by long-time heating at 300° and 400° F. is slightly greater, but the values obtained are still considerably in excess of the strength of completely annealed material.

* Effect of Temperatures Attained in Overhead Electric Transmission Cables. *Journal Institute of Metals*, Vol. 42, 1929, pages 321-329.

Fig. 10. Brinell Hardness of 2S, 3S and 4S at Room Temperature after Prolonged Heating.



Summary

The tests described in this paper have shown that, contrary to reports of some investigators, the hard tempers of 2S, 3S, and 4S are not materially softened by prolonged exposure to temperatures in the region of 200° to 300° F. Prolonged heating of 3S-½H at 300° F. causes no noticeable loss of hardness, and in the case of the other materials only a slight decrease of hardness is noted.

During prolonged heating of strain-hardened 2S and 3S at 212° and 300° F. there is no apparent change in tensile strength at these temperatures, but the yield strength is increased about 20%. This increase of yield strength has been attributed to relief of internal strain.

The full-hard tempers of 2S, 3S, and 4S lose their strength at elevated temperatures more rapidly than the half-hard tempers. The difference in the amount of cold work between the full-hard and half-hard tempers appears to decrease the temperature for complete annealing about 100° F.

Acknowledgment

The authors acknowledge the assistance of Mr. C. J. Renshaw and other members of the staff of the Aluminum Research Laboratories in carrying out the tests and preparing the data.

Rolling Mill Model

After eight weeks of continuous work, a model reproduction of the newest and most modern steel strip mill, to be completed at the River Rouge plant of the Ford Motor Company at the end of 1934, is being assembled in the Ford building at the Century of Progress Exposition in Chicago. The model, 42

feet long, and constructed in the scale of one-twenty-fourth of the size of the actual mill, was built under the direction of United Engineering and cost many thousands of dollars, while the huge mill, undergoing formation in United Engineering's several plants, will represent the expenditure of a vast sum on the part of the Ford Motor Company.

Activities of the Joint Research Committee on Effect of Temperature on the Properties of Metals

The Joint Research Committee of the A.S.T.M. and A.S.M.E. on Effect of Temperature on the Properties of Metals, at its June meeting, voted to draw up a definite plan, for submission to letter ballot, for experimental study of methods of evaluating the load-carrying ability of metals under prolonged stress at high temperatures. The "creep" of selected materials will be studied by test runs to be carried out, not merely for 1,000 or 2,000 hours, but for 3 years, or say 25,000 hours, in order that the validity of various methods of approximation and extrapolation and the relation of various "short cut" methods to actual long-time performance may be evaluated.

It also voted to study experimentally the progressive changes in toughness, during long exposure to high temperatures, of the 18—8 stainless steel whose creep properties have already been studied in detail by the committee and which are being reported in the July Transactions of the A.S.M.E. This continuation of the prior work on this steel is aimed to throw light upon the fact that this lot of material, though free from added "stabilizing" elements, was not embrittled by long sojourn under load at high temperatures in the creep tests. The question whether this austenitic steel passed through a brittle stage, without evidence in the creep curves of any change in load carrying ability, and then recovered from its brittle state, or whether it never did become embrittled, is of both theoretical and industrial importance, and a material whose other properties have been so thoroughly studied as is the case with this steel, is especially suited for such a study.

Besides these projects, which are in line with its past activities, the committee is extending its fields of active interest to include other matters of pressing industrial and engineering importance. The subcommittee on Oil Refinery Problems is working out an acceptable plan for procurement of experimental and operating information on still tubes for the oil-cracking industry. Petroleum refinery engineers, tube makers, and the Joint Committee are coöperating in the effort to apply the most modern methods of evaluation of properties and performance toward the development of better tubes and their most economical engineering application.

Another activity, also with a bearing on the oil industry, in relation to dewaxing problems, but also with many other industrial bearings, is the correlation of data on properties of metals at sub-zero temperatures. Many of the members of the Joint Committee are engaged in getting new data in this relatively unexplored field, and the formation of a new subcommittee to deal particularly with this problem will serve to unify these data and make them more generally available.

Still another new activity is a similar correlation of data on seizure—i.e., the effect of temperature on metal-to-metal wear, galling, and sticking. Users and makers of valves that operate at elevated temperatures find this an important problem in which available information is chiefly of an empirical nature. It is hoped to aid in the transition from empiricism toward a more sound basis for engineering design and selection of materials.

Thus the Joint Committee, while rigidly adhering to its policy of continued clarification of the fundamentals, is showing itself responsive to the engineering needs of the day in its selection of fields for immediate and intensive activity.

H. J. French, Chairman of the Joint Committee, announced the appointment and the acceptance of R. A. Bull as chairman of the subcommittee of the main committee on Finance. Major Bull's subcommittee is charged with the procurement of funds for the carrying out of the experimental program on fundamentals, that are of vital interest to all industries which use metals at high or low temperatures, and to those that produce such metals. More specialized projects with programs of special commercial interest to a particular branch of industry are to be financed apart from the fundamental program. An example of such a specialized interest is that of the oil industry, and its suppliers, in still tube materials, which is in the hands of a special subcommittee created for that specific purpose and which has its own finance committee headed by H. J. Kerr.

Richard L. Templin, chief engineer of tests, Aluminum Research Laboratories, New Kensington, Pa., recently was awarded the Charles B. Dudley medal by the American Society for Testing Materials for his paper "The Fatigue Properties of Light Metals and Alloys."

Advanced Course in Welding Engineering

Beginning July 23, a special five day course in welding engineering is being offered in Cleveland by the John Huntington Polytechnic Institute in coöperation with The Lincoln Electric Company. The course, being repeated at this time due to increased activity in the welding industry and to demand for an intensive advanced training course, will be conducted once each month except during August of this year. This course will provide engineers, welding supervisors and foremen an opportunity for intensive study of the practical and theoretical sides of welding. Day sessions will be held between 10:30 A.M. and 4:30 P.M. at the plant of The Lincoln Electric Company which has offered the facilities of its welding school under the direction of Arthur Madson and Dean Newton. Evenings between 7:30 and 9:30 will be devoted to lectures and discussions at the John Huntington Polytechnic Institute. The course will cover the following subjects: Value and use of the shielded arc; calculation and distribution of stresses in welded joints; study of polarized light and rubber weld models; penetration; designing for arc welding; organization of welding departments and estimating welding costs, etc.

This course is not to be confused with the regular Lincoln Welding School which has been in session regularly since 1917 when it was first inaugurated. The Lincoln Welding School is one of the largest of its kind in the world and thoroughly trains welding operators in every aspect of electric welding. Complete information on the five day course may be obtained from E. W. P. Smith, Welding Engineering Department, John Huntington Polytechnic Institute, Cleveland, Ohio.

New Metallurgical Laboratory

The Union Carbide Co., Buffalo Avenue and Forty-seventh Street, Niagara Falls, N. Y., with executive offices at 30 East Forty-second Street, New York, has approved plans for the construction of a new two-story and basement laboratory and experimental building for its metallurgical division, operated under the name of the Union Carbide & Carbon Research Laboratories, Inc. The new unit will be located on Forty-seventh Street near Royal Avenue, Niagara Falls, and will be of the H-type, 60 x 170 ft., with two wing extensions each 40 x 60 ft. As soon as the structure is completed it is proposed to remove the present metallurgical laboratories from Long Island City, N. Y., to the new location where the capacity and facilities will be increased.

Election of Officers, Chicago Chapter, A.S.M.

The Chicago Chapter of the American Society for Metals at its annual meeting elected the following officers for the year 1934-35: Chairman, H. A. Anderson, Western Electric Co.; vice-chairman, H. B. Knowlton, International Harvester Co., and secretary-treasurer, K. H. Hobbie, Driver-Harris Co. Executive committee was elected as follows: R. F. Anderson, Anderson-Shumaker Co.; R. A. Bull, consultant; J. F. Calef, Automatic Electric Co.; Otto F. Carl, Cyclops Steel Co.; L. A. Daines, Heppenstall Co.; Elmer Gammeter, Edison G.E. Appliance Co.; M. A. Grossmann, Illinois Steel Co.; J. E. Robinson, International Harvester Co.; C. L. Saunders, Brown Instrument Co.; A. J. Scheid, Jr., Columbia Tool Steel Co., and Jestyn Williams, Mills Novelty Co.

Murphy Elected Chairman of Board of E. F. Houghton & Co.

At a special meeting of the stockholders of E. F. Houghton & Company, oil and leather manufacturers, held on July 20, the office of Chairman of the Board was created and Louis E. Murphy, formerly president, was elected to that position. Mr. Murphy has been with the company 44 years; he was secretary from the time of its incorporation until elected vice-president in 1914, and continued in the latter office until he was elected president in 1929 following the death of Charles F. Carpenter. Major Aaron E. Carpenter was elected president and general manager. He has been with the company 29 years, was a member of the original Board, and served as treasurer from 1921 to 1929, when he became first vice-president. Major Carpenter represents the third generation of Carpenters to occupy the presidency of E. F. Houghton & Co. Other officers elected were: George W. Pressell, vice-president and director of sales; A. Everly Carpenter, 3rd, secretary; Dr. R. H. Patch, treasurer; C. P. Stocke, assistant secretary; Miss M. M. Menningen, assistant treasurer.

ORE CONCENTRATION (1)

JOHN ATTWOOD, SECTION EDITOR

The Concentration of Molybdenum Ores: A New Plant Erected in Morocco. *Chemical Age*, London, Vol. 29, Nov. 4, 1933, Metallurgical Section, pages 27-28. Description of new Mo ore reduction plant in Azegour South Marrakessh, 1
Morocco operated by Le Molybdene of Paris. Monthly production of 25 tons Mo concentrate with a content of over 85% MoS_2. VVK (1)

Progress in Concentrating Tintic Standard Silver-Lead Ore. C. A. SCHEMPP. *Mining & Metallurgy*, Vol. 14, July 1933, pages 291-292. The Tintic Standard Mining Co., Harold, Utah, treats low grade siliceous ores having an average content of:

Au, oz.	Ag, oz.	Pb, %	Cu	SiO_2	Fe	As
0.025	18.26	5.0	0.30	65.0	10.0	0.7

The process consists essentially of a chloridizing roast followed by a percolating
leach with a nearly saturated solution of common salt, acidified with H_2SO_4, then 2
precipitation of Ag on sponge Cu, and of Cu and Pb on Sn-plate cuttings. VSP (1)

Some New Practical Features in Iron Ore Concentration (Naagra Nyare Praktiska Rön inom Järnmalmanrikningen.) RAGNAR SALWÉN. *Teknisk Tidskrift*, Vol. 64, Apr. 14, 1934, pages 25-32. Describes the most recent developments and new types of apparatus, such as belt conveyors, pumps, sieves, crushers, grinding mills, magnetic separators, concentrating tables, filtering and dewatering equipment. Gives many examples of the successful use of rubber for combating wear and abrasion in this field. BHS (1)

Crushing, Grinding & Plant Handling (1a) 3

Screening: Some Problems and Essentials. H. J. HUDSON. *Crushing, Grinding, Mining & Quarrying Journal*, Vol. 2, Mar.-Apr. 1934, pages 161-164. Discussion of various types of screens and their development. AHE (1a)

Grain Composition of a Ground Product as Seen by the Theory of Probability (Die Kornzusammensetzung des Mahlguts im Lichte der Wahrscheinlichkeitslehre.) P. ROSIN & E. RAMMLER. *Kolloid-Zeitschrift*, Vol. 67, Apr. 1934, pages 16-26. Crushing and grinding (comminution) of a material is considered as a statistical phenomenon; it is shown how mathematical statistics can be employed for
calculating the grain size composing a ground material. The distribution curves 4
of grain size are developed and formulas derived for various types of mills and crushers from coarsest to finest grains. 8 references. Ha (1a)

Mining and Concentration of the Ilsede Iron Ore Deposits (Gewinnung und Aufbereitung der Eisenerze der Ilseder Hütte). H. ROHNE. *Stahl und Eisen*, Vol. 53, Dec. 21, 1933, pages 1325-1330. Some of the ore is merely sifted and the fines sintered; most of it requires treatment, however. Ores differing in Mn and P content and in SiO_2-CaO ratio are combined to make a self-fluxing mix for Thomas pig iron. The operation of a Meixner ore washing machine is described in which an ore with 32% Fe is enriched to 41% Fe, the output being about 80 tons per man per shift. SE (1a)

Flotation (1c) 5

Influence of Pulp Classification upon Flotation. V. I. TRUSHLEVICH & L. M. ALEXEEV. *Tsvetnaie Metallui*, Jan. 1933, pages 26-43. In Russian. The authors investigated the influence of dry and wet classification of pulp on flotation, and studied the economic factors and schemes of the most profitable grinding with classification both in laboratory and commercial ore dressing plants. Flotation of classified pulp ground to 65 mesh and coarser gave results superior to flotation of material through 200 mesh. BND (1c)

The Adsorption of Copper Sulfate by Sphalerite and Its Relation to Flotation. S. FREDERICK RAVITZ & WILLIAM A. WALL. *Journal of Physical Chemistry*,
Vol. 38, Jan. 1934, pages 13-18. With sphalerite particles larger than about 37 6
microns, the amount of copper sulphate which gives the best flotation recoveries is equal to the amount required to form a monomolecular film of CuS. With smaller particles, maximum recovery is obtained with less than the amount of copper sulphate required for a monomolecular film, the difference between the amount required for maximum recovery and that required for a monomolecular film increasing with decrease in particle size. A simple explanation is offered to account for these flotation results. The amounts of Cu absorbed by sphalerite of various sizes from a 0.02 M $CuSO_4$ solution are equivalent to surface films of copper sulphide many molecules thick. The "thicknesses," however, decrease as the particles become smaller. An explanation of the results of the adsorption tests by change
of surface forces with size appears improbable. The theory of the mosaic struc- 7
ture of metals, however, provides an explanation which agrees very satisfactorily with the results obtained. The adsorption tests indicate that the unit blocks of sphalerite are approximately 0.37 micron in length. EF (1c)

Parallelism between Wetting Isotherms and Flotation Curves (Parallelismus zwischen Benetzungsisothermen und Flotationskurven) MARIE LIPETZ, P. REHBINDER & MARIE RIMSKAJA. *Kolloid-Zeitschrift*, Vol. 66, Mar. 1934, pages 273-276. The predominance of capillary-physical phenomena over purely chemical phenomena in the flotation process is emphasized and scientific and practical investigations of the flotation mechanism described. The physical process is divided into 3 stages: production of an aqueous ore suspension in which adsorption
of dissolved reagents to the mineral particles occurs; production of an emulsion 8
in this suspension of gas (air) bubbles by surface-reactive agents, and fixing of imperfectly wetted or non-wettable particles to gas bubbles, producing a mineralized gas emulsion consisting of the 3 phases mineral-aqueous phase-air. The behavior of the mineral in these stages and the yield of flotation as a function of addition of reagents are discussed; the tests show that a pronounced parallelism exists between the wetting isotherms and the flotation curves. 7 references. Ha (1c)

Magnetic Separation (1d)

The Laboratory Concentration of a High-Sulphur Magnetite from Texada Island, 9
B. C. T. W. HARDY & H. H. BLEAKNEY. *Canadian Department of Mines, Mines Branch*, Report No. 736, 1934, pages 276-278. A high-grade magnetite, assaying Fe 61.86, S 2.10, P 0.015, Mn 0.10, Cu 0.10 and insoluble 11.05% was concentrated (wet, magnetic) to give a concentrate (80.9-85.5% recovery) containing Fe 68.46-71.55, insoluble 1.02-5.01 and S 0.08-0.44%. Fe recovery was 93.6-94.6, insoluble rejection 62.1-92.5 and S rejection 82.0-96.9%. (The variations are for different sizes). Even at —14 mesh a product is obtained suitable for conversion to sponge Fe. Grinding to —60 mesh is the best practice. AHE (1d)

Amalgamation, Cyanidation & Leaching (1e) 10

Is the Gold in Tellurides Soluble in Cyanide? H. E. T. HAULTAIN & W. E. JOHNSTON. *Transactions Canadian Institute of Mining & Metallurgy*, Vol. 36, 1933, pages 217-220. See *Metals & Alloys*, Vol. 4, May 1933, page MA 162. AHE (1e)

ORE REDUCTION (2)

A. H. EMERY, SECTION EDITOR

Non-Ferrous (2a)

Extraction of Secondary Copper from Low Grade Scrap and Slags. P. S. BELONOGOV. *Tzvetnuie Metallui*, No. 2-3, Mar.-Apr. 1933, pages 94-101. Describes the process for the recovery of Cu from slags and scrap as practiced at the Krasnuiy Vulborjets Works (Russia). BND (2a)

Production of Pure Chromium. P. P. ALEXANDER. *Metals & Alloys*, Vol. 5, Feb. 1934, pages 37-38. D.Sc. in Met. thesis, Massachusetts Institute of Technology. Pure Cr trioxide produced by distillation in vacuum was converted into chromic oxide in vacuum at 850° C. The difficulties in the H_2 reduction of Cr oxide due to O_2 in the gas and water generated by the reaction have been obviated by the use of metallic hydrides such as those of Ta and Ca which release large quantities of pure H under suitable conditions of temperature and pressure. Spectroscopically pure Cr was produced using Ta hydride, except for a trace of Na. Ca hydride produced Cr of 99.95% purity. Similarly with suitable temperatures and refractories, oxides of Th, B, Be, and V were reduced. By this method using moderate temperatures, metals of controllable purity can be produced economically. 31 references. WLC (2a)

The Volkhov Aluminum Combine. D. M. CHIZHIKOV. *Tzvetnuie Metallui*, No. 4, May 1933, pages 3-12. Usual processes of obtaining Al from bauxites containing low SiO_2 (3-4%) are not applicable to Russian bauxites found in large quantities at Volkhov because they are low in Al and contain up to 20% SiO_2. The laboratory experiments and plant tests made in an attempt to develop a practical extraction process are described. The principal difficulties of the process have not yet been solved, and no practicable process of treating the ores has been worked out. BND (2a)

Production of Pure Aluminum (Gewinnung von Reinaluminium). PAUL RÖNTGEN & HEINZ BORCHERS. *Metall und Erz*, Vol. 31, Feb. 1934, pages 81-86. A process was developed on a laboratory scale for the production of pure Al_2O_3 from impure Al or Al alloys containing considerable quantities of Fe, Si, and Cu. The Al alloy is melted with cryolite in a very pure graphite crucible and heated to 1000°-1200° C. while O is passed through. Only the Al is oxidized and dissolves in the cryolite. The process is continued on until the cryolite contains about 50% Al_2O_3. This mixture can be used in the regular electrolytic reduction process for the production of pure Al. Another process and furnace were developed for the simultaneous purification by oxidation and electrolytic reduction of Al. The furnace, consisting of two compartments, is lined with Cu, water cooled, and has a water cooled Cu partition and water cooled bottom. The anode compartment contains the molten electrolyte consisting of very pure cryolite and 20% pure Al_2O_3, the cathode compartment contains the impure molten Al. Al containing over 10% Fe and 10% Si, also Al containing carbide, was used for anodes. The O formed at the anode during electrolysis oxidizes the impure Al, which dissolves in the cryolite, and the impurities are drawn off at intervals. The current efficiency is very high. The Al produced in this way contained as low as 0.12% Fe and 0.23% Si. CEM (2a)

Ferrous (2b)

A Goal in Blast Furnace Practice. HENRY T. RUDOLF. *Blast Furnace & Steel Plant*, Vol. 22, May 1934, pages 261-262. Rate of heat transfer from the stoves to the furnace is an important factor in blast-furnace operation. Development of a rate-of-heat meter or integrating calorimeter, which would tell how many B.t.u. have entered the furnace in a specific period of time, would afford an earlier means of swing detection than at present available. This would enable considerable savings to be made in cost of production on large hearth furnaces, particularly where the tonnage demand is close to capacity and the analysis of the Fe held within narrow limits. MS (2b)

Oxygen Enriched Blast for Iron Smelting. B. M. SUSLOV. *Metal Progress*, Vol. 25, Jan. 1934, pages 40-41. A blast enriched with O_2 reduced the fuel consumption and made possible higher Fe temperatures in a basic-lined blast furnace. The introduction of steam just above the bosh when using such blast produces a stack gas that has possibilities as a raw gas for NH_3 synthesis. The enriched blast gases decrease in volume and increase in fuel value with increased enrichment. WLC (2b)

Reduction of Ore Cubes in Hydrogen (Reduktionsversuche an Erzwürfeln im Wasserstoffstrom). W. BAUKLOH & K. FROESCHMANN. *Stahl und Eisen*, Vol. 54, April 26, 1934, pages 415-416. Fe ore cubes were reduced in a H_2 stream and the effect of temperature and rate of flow of the gas on the thickness of the reduced Fe layer was determined. The rate of reduction was at a minimum at 920°C. due to the α-γ transformation decreasing the diffusion of H_2 into the Fe. Otherwise the rate of reduction increased with temperature and rate of flow. SE (2b)

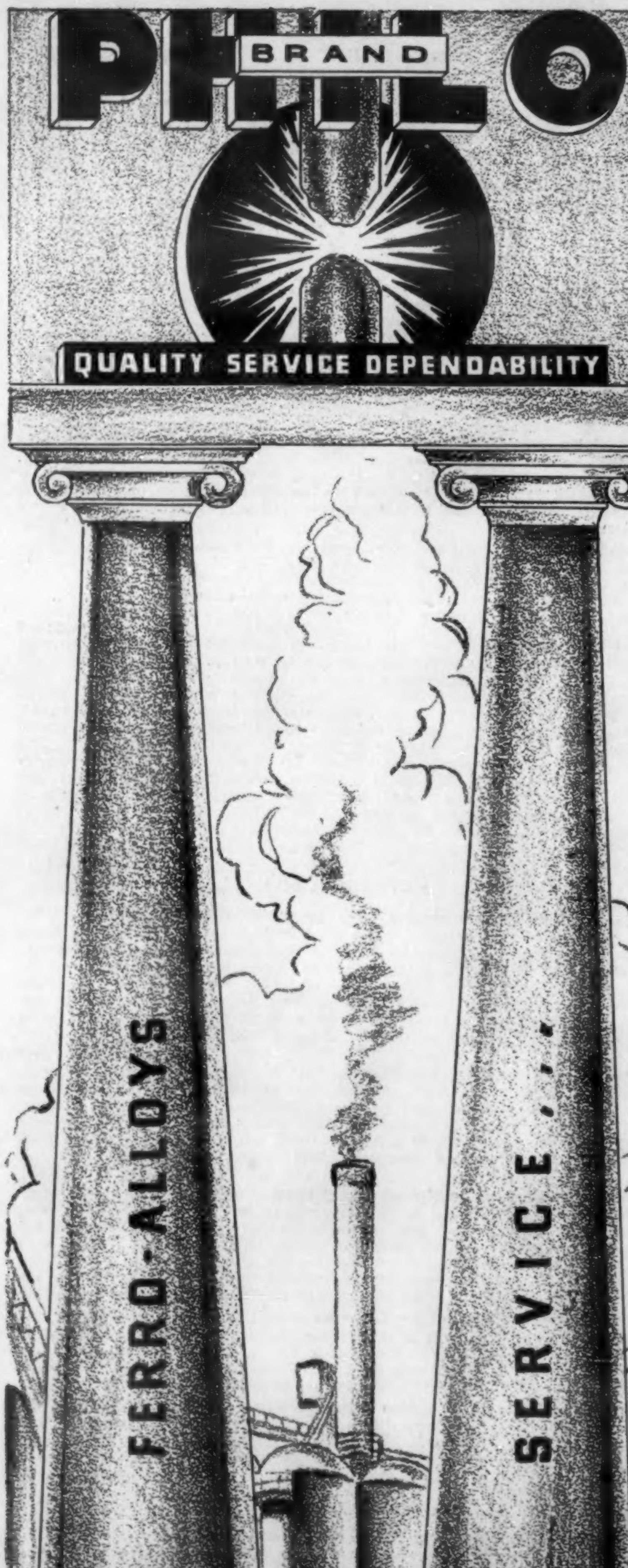
Direct Production of Iron (Zur Frage der unmittelbaren Eisengewinnung). R. DURRER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Apr. 28, 1934, pages 513-515. Present methods of procuring Fe by direct reduction of the ore are reviewed briefly and the methods of Basset, Flodin-Gustafsson, Höganäs, Kalling and Ekelund are described. Direct and indirect methods are compared. Ha (2b)

The Production of Sponge Iron from Moose Mountain (Ont.) Concentrate. T. W. HARDY & H. H. BLEAKNEY. *Canada Department of Mines, Mines Branch*, Report No. 736, 274-276 (1934). Briquet screenings assaying Fe 64.13, P 0.018, S 0.006, SiO_2 6.96 and moisture 0.02% were metallized, 3 hours at 1700° F., 1 hour at 1800° F., passed over a dry magnetic separator and briquetted. Metallization was 99.3%. The product contained Fe 87.37, P 0.02 and S 0.01%. Steel making tests were satisfactory. AHE (2b)

The Production of Sponge Iron from Texada Island (B. C.) Iron Ore. T. W. HARDY & H. H. BLEAKNEY. *Canada Department of Mines, Mines Branch*, Report No. 736, 1934, pages 269-273. A high grade magnetite ore assaying Fe 62.06, S 0.15, Mn 0.10, P 0.056, Cu 0.045%, was concentrated (Gröndal magnetic separators), sintered and 700 lbs. of sponge Fe of excellent quality made. The suitability of this Fe for manufacturing low-S, low-P steel was demonstrated. The concentrate assayed Fe 70.25, S 0.01, P 0.02, and insoluble 3.39%. Fe recovery was 96.4, S rejection 94.3, P rejection 69.6, and insoluble rejection 74.9%. Reduction was made at 1800° F. for 6-7½ hours using city gas. Product assayed Fe 89.17; metallization was 97.5%. AHE (2b)

Preparation of Ferrochromium in the Electric Furnace (Sur la Préparation du Ferro-Chrome au Four électrique). B. BOGITCH. *Industrie Electrique*, Vol. 43, Apr. 10, 1934, pages 164-165; *Journal du Four Electrique*, Vol. 43, Jan. 1934, page 12. The usual method of production of ferrochromium yields a product high in C. Tests in a special electric furnace with graphite electrodes yielded a material rich in Cr and low in C. Best yields were obtained with an alloy containing 1.5-2% C and 69% Cr. To improve the Cr content requires a separate reduction of the ore before melting which is uneconomical. Ha + JDG (2b)

Sintering Tests on High-Sulphur Magnetite from Texada Island, B. C. T. W. HARDY & H. H. BLEAKNEY. *Canada Department of Mines, Mines Branch*, Report No. 736, 1934, pages 279-281. A high-grade magnetite assaying Fe 62.27, S 2.10, P 0.015, Mn 0.10 Cu 0.10 and insoluble 11.05% was crushed to -3 mesh, and concentrated magnetically (dry) to give a product assaying Fe 66.39, S 1.30 and insoluble 7.09% with a S rejection of 44.5% and Fe recovery of 95.9%. A mix of 94% ore, 2.5% coke and 3.5% moisture sintered well. AHE (2b)



MELTING, REFINING & CASTING (3)

Material Handling in Foundry (La Manutention en Fonderie). ROCHE. *Arts-et-Métiers*, Vol. 85, Nov. 1933, pages 290-292. Layout of a gray iron foundry for locomotive works output of which is 500 tons monthly is discussed. It is pointed
1 out that handling must take account of the 3 following points: (1) Handling for stocking materials: pig iron, coke, sand and miscellaneous. (2) Handling during processing: metal to be melted, sand, etc. (3) Handling of processed product; molten iron, shaken out sand, castings, etc. The author gives a layout of a foundry which allows particularly simple handling for the third class. FR (3)

Tamping of Sand and Its Application in the Choice of Types of Molding Machines (Étude du Serrage et son Application au Choix des Types de Machines à mouler). E. RONCERAY. *Revue de Fonderie Moderne*, Vol. 28, Apr. 10, 1934, pages 97-102; Apr. 25, 1934, pages 122-125. Modern tendency to large production forces use of mechanical tamping, by hydraulic or mechanical pressure. Various methods and types of equipment for molding machines are discussed. Ha (3)

**Example of a Very Simple Foundry Defect Which Can Be Suppressed With a
2 Little Care (Exemple d'un Défaut de Fonderie de Nature très Simple et qu'un Peu de Soin Fait Disparaître).** GUY HÉNON. *La Fonte*, Vol. 3, Oct.-Nov.-Dec. 1933, pages 372-373. Defect described is that of blowholes arising in heavy parts of castings in the vicinity of inside chills or metal inserts; when these metal parts are dirty, wet or oxidized, gases are evolved at contact with molten metal and can cause gas holes. Such defects can be overcome by changing design of castings when possible, by using very open molding sand. When inserts have to be used they can be annealed in a reducing atmosphere, sand blasted or tin plated, furthermore they should be set in the mold as late as possible before closing the mold. FR (3)

Scrap Metals—Their Recovery in Australia and New Zealand. M. W. VON BERNEWITZ. *Chemical Engineering & Mining Review*, Vol. 26, Apr. 5,
3 1934, pages 265-271. WHB (3)

Modern Methods in Foundries (Les Méthodes modernes dans les Fonderies). *Revue de Fonderie Moderne*, Vol. 28, May 10, 1934, pages 138-139. A few molding machines and molding methods are described. Ha (3)

Ladles and Pouring Efficiency. ALBERT J. SAUTE. *Foundry*, Vol. 61, Sept. 1933, pages 36, 40. Discusses use of ladles of correct capacity for the same line of castings to obtain the greatest pouring efficiency, the least foundry over-melt, the lowest cost for the pouring operation and higher % of good castings. VSP (3)

Check Reduces Casting Losses. PAUL R. RAMP. *Foundry*, Vol. 62, Jan. 1934, pages 13, 36, 38. Discusses method used to reduce casting losses due to defects.
4 Methods used are a daily form report for defective castings and instructions to molders to correct the defects. VSP (3)

Non-Ferrous (3a)

G. L. CRAIG, SECTION EDITOR

Some Factors which Influence Porosity of Bronze Castings (Note sopra alcuni Fattori che influenzano la Porosita dei Getti di Bronzo). E. J. L. HOWARD. *L'Industria Meccanica*, Vol. 16, Apr. 1934, pages 277-280. See "Some Factors Affecting the Soundness of Bronze Castings," *Metals & Alloys*, Vol. 4, Nov. 1933, page MA 363. Ha (3a)

Recent Die Casting Developments Open New Fields for Product. SAM TOUR &
5 F. J. TOBIAS. *Steel*, Vol. 94, Feb. 5, 1934, pages 25-27, 30. Recent noteworthy developments are new Zn-base alloys, a new type of casting machine, and a new die steel for Al castings. New Zn-base alloys have superior physical properties, high impact strengths, and negligible dimensional changes. Zamak No. 3, containing 4% Al, 0.05% Mg, and balance high-grade Zn, is regarded as one of the best and most desirable of the new alloys. Joseph Polak, Prague, has developed a new type of casting machine, using pressures of 4,000-15,000 lbs./in.^{2}, making it possible to cast non-ferrous metals and alloys at much lower casting temperatures. With 60-40 brass, temperature is as low as 1575°F. In this machine, metal pot is separate from the actual machine. Molten metal is transferred before every shot by a hand ladle into a cold chamber which is a part of the machine. Castings pro-
6 duced on these machines are sometimes called "pressure castings." In the United States, this type has already opened the brass field to the die-casting industry, and will soon open new fields for Al, Mg, and Zn-bass alloy die castings. New die steel contains 0.30% C, 1% Si, 5% Cr, 1% W, and 1.5% Mo, and makes the production of Al die castings more economical. Tabulates physical properties of various alloys. MS (3a)

Brass Pressure Castings are Produced Economically. WILLIAM W. SEIG. *Iron Age*, Vol. 132, Nov. 30, 1933, pages 16-19. Describes Polak die casting machine worked by hydraulic pressure of between 3000 and 6000 lb./in.^{2} Composition of brass recommended is Cu 60%, Pb 0.75%, Sn 0.050% and Zn 38.75%. Compares forging and pressure casting of brass, and properties and structure of resulting products. VSP (3a)

**The Solubility of Gases in Copper and Aluminum (Über die Löslichkeit von Gasen
7 in Kupfer und Aluminium).** P. RÖNTGEN & F. MÖLLER. *Metallwirtschaft*, Vol. 13, Feb. 2, 1934, pages 81-83 and Feb. 9, pages 99-100. The apparatus and procedure were similar to those used by Braun. It was found that N, CO_2 and CO are not soluble in either solid or liquid pure Cu. N and CO_2 are not soluble in Cu containing .5% Cu_2O, or .5% Cu_2S, or .1 to .3% Al. Cu containing .5% Cu_2S absorbs H, part of which dissolves, part forming H_2S. When it is cooled the dissolved H is expelled from the Cu, but the combined H is retained. Part of the S is driven off by H from solid Cu. H produces porosity in Cu. The solubility of H in pure Cu, both solid and liquid, is reduced by the addition of Al to the Cu. The reduction is proportional to the Al content up to the point where the β phase appears. In Cu containing 8.1% Al the solubility curve for H turns sharply upward
8 at 930°C. H is soluble in liquid pure Al and Al containing 3% Cu, but not in solid Al. The solubility results are given in graphs and agree closely with those of Braun and of Sieverts but do not agree with those of Iwase. 16 references. CEM (3a)

Treatment of Platinum-Iridium Scrap. C. CAMPBELL. *Chemical Age*, London, Vol. 29, Aug. 5, 1933, Metallurgical Section, pages 9-10. Reprint from July 1933 issue of *Sands, Clays & Minerals*, Detailed process for recovering Pt and Ir from scrap. VVK (3a)

Secures Uniformity in Composition. PAT DWYER. *Foundry*, Vol. 62, Jan. 1934, pages 10-12, 35. Describes the development of melting, molding and cleaning of castings at the Fostoria gray Fe division of Electric Auto-Lite Co. Lining diam. of
9 each cupola has been reduced from 66 to 33 in. extending only a few feet above melting zone. Anticipated analysis of castings approximates: Si 2.75%, S 0.095%, Mn 0.54%, P 0.15% and total C 3.40%. Sprues and gates are placed in molds to lift out pigs. VSP (3a)

Gas-Free Metals Used in X-Ray Tubes. W. D. COOLIDGE & E. E. CHARLTON. *Metal Progress*, Vol. 24, Nov. 1933, pages 36-40. Describes methods of producing metals free from gas for target and cathode of X-ray tubes. Gases are removed from W and Mo by thermal treatment in vacuum. WLC (3a)

Metal Loss and Its Effect on the Economy of the Foundry) Der Metallverlust und sein Einfluss auf die Wirtschaftlichkeit der Metallgiesserei). ERICH BECKER. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Apr. 1, 1934, pages
10 142-144; Apr. 15, 1934, pages 161-162. In non-ferrous metal foundries material costs are of prime consideration for economic founding. Author discusses at length savings effected by decreasing metal loss and describes a scheme for following metal loss in daily foundry production. Discussed are metal losses owing to melting procedure, casting and cleaning. Numerical example exemplifies considerations. GN (3a)

Ferrous (3b)

C. H. HERTY, SECTION EDITOR

Use of Sodium Carbonate in Iron and Steel Works. N. L. Evans. *Iron & Coal Trades Review,* Vol. 128, Mar. 23, 1934, page 494. Attention is called to the increased use of sodium carbonate (the anhydrous form of the familiar washing soda) as a cleansing flux and desulphurizing agent for cast irons and some non-ferrous metals; its useful operating range of about 600° extends from its melting point at 851° to 1450° C., which includes Cu, brass, bronze and cast Fe. A good place to use sodium carbonate is the fore-hearth, especially in mass production foundries; in order to ensure efficient separation of the flux from the metal the latter is poured from a teapot-type of ladle in which the metal is drawn, by a syphon effect, from the bottom of the ladle. Owing to its degasifying action sodium carbonate helps to eliminate shrinkage cavities, gas holes, and to reduce the S content; a better machinable casting is obtained. In melting brass and bronze it is equally useful. Ha (3b)

Treatment of Melts by Slags High in Ferrous Oxide and Acidic Slags Low in Ferrous Oxide On Crystallization and Mechanical Properties of Gray Cast Iron (Einfluss der Schmelzbehandlung durch eisenoxydulreiche und saure oxydularme Schlacken auf die Kristallisation und die mechanischen Eigenschaften von grauem Gusseisen). P. Bardenheuer & A. Reinhardt. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 16, No. 6, 1934, pages 65-75. The change in chemical composition, content of O and gases, bending strength and deflection, tensile strength and Brinell hardness was determined for hypo-eutectic, eutectic and hyper-eutectic melts with from 0.5 to 5% Si at 1500°-1600° C. as function of slags with varying FeO contents. When treated with FeO-rich slag solidification took place in all melts without undercooling in the stable system; after treatment with acidic FeO-poor slag crystallization takes place after undercooling. The mechanical properties depend on the differences in the structure connected with the different slags. Treatment with FeO-poor slag reduces greatly bending and tensile strength of hypo-eutectic low C alloys irrespective of Si content, 29% for bending and 50% for tensile strength was found as maximum decrease; the reduction is less for medium C contents, for 3.4% C no difference was observed, while above 3.4% both strengths are increased. Deflection becomes smaller, Brinell hardness is not affected by the slag treatment. In hyper-eutectic alloys, tensile strength is increased by treatment with FeO poor slags for low Si contents while it is reduced for high Si contents. Brinell hardness is lower in Si-poor and C-rich melts after treatment with FeO-rich slag than with FeO-poor slag; the hardness increases under the influence of FeO-rich slag considerably with increasing Si and decreasing C content and is much higher than after treatment with FeO-poor slag. Content of O and gases is higher in hypo-eutectic melts with FeO-rich slags, lower with FeO-poor slags; hyper-eutectic alloys do not show this regularity. 26 references. Ha (3b)

Principles of Deoxidation with Manganese and Silicon. A. Reactions between Carbon-free Liquid Iron and Iron-Manganous Oxide-Silicates saturated with Silicic Acid. B. Equilibria of Deoxidation of Liquid Iron with Manganese Silicon (Die Grundlagen der Desoxydation mit Mangan und Silizium. A. Die Reaktionen zwischen kohlenstofffreiem flüssigen Eisen und an Kieselsäure gesättigten Eisen-Manganoxydul-Silikaten. B. Die Gleichgewichte der Desoxydation flussigen Eisens mit Mangan und Silizium). F. Koerber & W. Oelsen. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 15, No. 21, 1933, pages 272-309. In order to be able to determine equilibrium constants directly from the melt which has so far not been possible for acid steel processes because the material used for crucibles always reacted with the silica melts, crucibles were made of pure sand which permitted to observe directly the equilibria between liquid Fe and Fe-Mn-silicates saturated with SiO_2 for reaction temperatures of 1550, 1600, and 1650° C. It was found that the equilibria of the individual reactions

$$[Mn] + (FeO) \leftrightarrows (MnO) + [Fe],$$
$$[Si] + 2(FeO) \leftrightarrows (SiO_2) + 2[Fe], \text{ and}$$
$$[Si] + 2(MnO) \leftrightarrows (SiO_2) + 2[Mn].$$

and their relations can be represented by the ideal mass law within the limits of error of the experiments. The distribution of ferrous oxide between metal and slag can be given by Nernst's law. The O content of the Fe melt is, for constant temperature, proportionate to content of ferrous oxide of the slag; the division coefficient [O]/(FeO) increases considerably with increasing temperature. The formulas of van't Hoff represent very satisfactorily the heat of reaction as difference of the heats of formation of the solid slag forming constituents. Pure liquid Fe is able to reduce Si from SiO_2 if the content of ferrous oxide in the slag is sufficiently low. The results point to the fact that Fe-Mn-silicates are dissociated electrolytically to a great extent in "free" lower oxides and "free" silicic acid which causes a dislocation of the Mn equilibrium by the addition of silicic acid to pure ferrous oxide slags. On the basis of the reaction equilibria the deoxidation equilibria and the quantitative relations of Si alone are determined for different O contents. Space models are developed which are to illustrate the equilibria between liquid Fe and different oxidation products which are separated from the melt with varying contents of Mn, Si and O. Practical suggestions are derived for the most favorable ratios of quantities of Mn and Si for common deoxidation. Ha (3b)

Limits of Capacity of the Foundry Cupola Furnace (Die Leistungsgrenzen des Giessereischachtofens.) A. Achenbach. *Die Giesserei,* Vol. 21, Mar. 16, 1934, pages 109-115. Grey iron is still the most preferred material on account of its cheapness and easy machineability; contrary to steel the mechanical properties of pure tensile and bending strength are not alone the determining factors for its application but, to a much larger degree freedom from pipes, easy machineability and pourability. The metallurgical conditions for producing a pearlitic basic structure and the effect of combustion and melting process on formation of structure are discussed; it is shown that charge and melting process have to be adjusted to each other. The time required for each of these items in conjunction with the dimension of the furnace is the basis for the capacity of the cupola. Formulas are developed for the calculation of capacity taking into account furnace dimension, physical conditions of charge and operating conditions; a few examples illustrate how the capacity of existing furnaces could be increased by making changes in the furnace in such manner as to approach better theoretical conditions. Ha (3b)

A Contribution to Pattern Making: A Pressure Cylinder (Ein Beitrag zum Modellbau: Ein Presszylinder). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 1, 1934, pages 145-146. Discusses suitable method adopted in making pattern of mentioned part. GN (3b)

Making the Mold of a Covering Ring According to 2 Molding Methods (Die Herstellung der Form zu einem Abschlussring nach zwei Formmethoden). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 15, 1934, pages 165-167. Discusses making of mold (1) by sweep, (2) by pattern of a parted ring. From the practical and economic point of view, first method is better. GN (3b)

Winged Ingot Improves Structure of Steel. Donald G. Clark. *Iron Age,* Vol. 132, July 6, 1933, pages 22-23, 68. This method of casting eliminates an undesirable structural condition at the center of ingots and also a distinct advance in quality and uniformity. Describes the various tests conducted on common ingots and winged ingots. Winged ingot process was developed to make more uniform tool steels, while it also offers possibilities in making of nearly all kinds of steel because of the economy of manufacture and the better working qualities of the more homogeneous material. VSP (3b)

Jolting Steel Ingots as they Solidify (Rüttelversuche bei erstarrendem Stahl). E. HERZOG. *Stahl und Eisen,* Vol. 54, May 10, 1934, pages 462-465. A patent on jolting ingots was granted as early as 1889 and renewed attempts to do this have periodically been made. In experiments with jolting ingots now going on at the Aug. Thyssen works at Duisberg-Hamborn, 3-ton ingots could be jolted in a machine which raised and lowered the ingots through a height of 22 mm. as often as 4.3 times a second, or of course, less frequently if desired. In rimming steel, jolting too soon after pouring caused excessive segregation; to avoid this jolting had to be delayed for ½ to ¾ of an hour after teeming, after which the jolting had little effect. Even in killed steel jolting had to be delayed until the ingot top froze over. Although it is too soon to draw a positive conclusion jolting has not proved to be of benefit. In discussion it was stated that jolting tended to reduce the grain size on the one hand, but on the other to cause hot-tears or cracks. SE (3b)

Causes of Frequent Irregularities in Open Hearth Operation (Woran liegen die häufigen Unregelmässigkeiten bei dem Siemens-Martinofenbetrieb). WILH. SCHNEIDER.. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 15, 1934, pages 156-158. Author discusses difficulties encountered in making in open hearth furnace 10 ton heats of malleable cast Fe. Careful examination of heating conditions in checkers proved failure of insufficient heat supply in furnace to be due to insufficient heating up of air checkers. By arranging separat flues for air and gas checkers each provided with a special damper difficulty was eliminated and heats were then made successfully. GN (3b)

Arrangement of Patterns on Plates in Molding Malleable Cast Iron Parts (Ueber das Anlegen von Modellplatten zum Formen on Tempergussteilen für kleinere Stückzahlen). W. SCHNEIDER. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 18, 1934, pages 114-116. Paper discusses in detail most suitable methods of arranging different types of malleable cast Fe parts on a molding plate. Of essential importance for obtaining sound castings in this case is proper gating and arrangement of special suction gates. A number of examples describing gating procedure is considered. GN (3b)

Slagging of Manganese and Iron in the Basic Bessemer Converter (Die Verschlackung des Mangans und Eisens in der Thomasbirne). O. SCHEIBLICH. *Stahl und Eisen,* Vol. 54, Apr. 5, 1934, pages 337-344; Apr. 12, 1934, 365-370. The slagging of Mn in the basic Bessemer converter depends mainly on the basicity; a low basicity of the slag promotes slagging. A high Mn content in the pig iron raised the Fe content of the slag. The effect of basicity and P and Mn content on the value of the equilibrium constant in the reaction $FeO + Mn = MnO + Fe$ as determined from basic Bessemer blows is shown in several graphs. SE (3b)

Centrifugal Casting (Der Schleuderguss). A. VÄTH. VDI Verlag, Berlin, 1934. Paper 6 x 8¼ inches, 107 pages. Price 6.90 RM.

The history of centrifugal casting, the mathematics of the centrifugal forces involved, segregation of constituents and release of gas and slag, are discussed in general terms. Specific attention is paid to centrifugal cast iron pipe in relation to types of equipment, segregation, etc., with some comment on automotive pistons, cylinders and brakes. Brief comment is made on centrifugal castings in steel, brass and bronze. Still briefer comment is made on those of leaded bronze, on babbitting of bearings and on dental castings.

The pamphlet gives a glance at the subject, but is not very comprehensive nor fully up to date. H. W. Gillett (3b)—B—

Physico-chemical Transformations in a Liquid Mass Cast and Subjected to Centrifugal Action During Solidification (Étude sur les transformations physico-chimiques d'une masse liquide coulée pleine et soumise à une action de centrifugation pendant le cours de sa solidification). LAZARE QUINCY. *Revue de Métallurgie,* Vol. 31, Feb. 1934, pages 68-89. Amounts of metal introduced at one time in centrifugal casting must be quite small. With the larger amounts solidification proceeds both from the inside and outside producing a segregation zone in the middle of the solidified metal. When a mold is fully filled, closed and rotated, solidification occurs from the outside only. Shrinkage cavity is perfectly cylindrical and is located in the exact center of the casting. Non metallic inclusions are segregated in it. The body of the metal is practically freed of gas which collects in the cavity. In one case reported it contained 93% H_2 and was under 3 atmospheres pressure at room temperature. Selective crystallization causes the formation of three layers of different carbon content in case of cast iron. The outside layer has the lowest content, the intermediate layer has the highest and the core itself an average content of the metal. An explanation is offered for this. Graphitic lamellae are less numerous and smaller in the outside layers. S is removed towards the central cavity. With ladle analysis 0.105 S a centrifugal casting contained 0.067 S in the outside layers and 0.028 in the core Most of the S was found on the surface of the cavity, the analysis of which gave: 3.49 S and 6.22 Mn. P is distributed similarly to C. Si and Mn (not combined with S) are unaffected. The beneficial influence of centrifugal casting on the surface of casting is particularly pronounced on rolls which last much longer in service. In case of steel C, S and P are reduced in the outside layers and increased, in comparison with the average in the central zones. Si and Mn are not affected. 34 illustrations, 6 tables. JDG (3b)

Further Investigations into the Metallurgical Course of the Thomas Process (Weitere Untersuchungen über den metallurgischen Verlauf des Thomasverfahrens). F. BARDENHEUR & G. THANHEISER. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 15, No. 22, 1933, pages 311-314. To get an insight into the metallurgical principles of steel production by the Thomas process the changes of concentrations in melt and slag during the time of blasting were determined in 9 Thomas melts. The degree of basicity was measured by analysis of the slag of reaction which was freed from free lime and the transition of the originally acid into the basic slag followed up by determining the equilibrium constant for the Mn reaction K_{Mn}. The general course of the Thomas process can be represented as follows: the O blown into the melt with the air oxidizes at first a part of the Fe to ferrous oxide; other elements as Si, P, Mn, C, etc., are oxidized essentially over ferrous oxide. Si, Ti and V and a great part of Mn burn at the beginning of the melting process with very great velocity. The silicic acid formed can form very liquid compounds with simultaneously formed ferrous and manganous oxide which separate quickly from the steel melt. V and Ti are accumulated at the beginning of the reaction in the slag. Only after all these elements are burnt is C eliminated. During the whole time of burning of C the O content of the melt is low in spite of the great amount of air supplied. Dephosphorization takes place when the slag has become basic. Ha (3b)

Finishing the Heat of Steel. Pt. XVII-XVIII. J. H. HRUSKA. *Blast Furnace & Steel Plant,* Vol. 22, Feb. 1934, pages 101-102; Mar. 1934, pages 161-162, 176. Precautions to be observed in pouring, particularly bottom pouring; comparison of principal types of ingot-molds and methods of pouring; heat transfer between ingot and mold; and formation of air gap between ingot skin and mold wall. Data obtained on the last 3 subjects are presented in tables and curves. Includes 11 references on thermo-physics of ingots. MS (3b)

Ferro-Alloys in Steel Making. C. H. HERTY, JR. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, pages 68-70. Discusses the purposes for which ferro-alloys are added to liquid steel. These are to make an alloying addition to the steel; to deoxidize the bath; to insure the correct chemical analysis of the heat; to "shape up" the slag and allow the temperature of the metal to be adjusted by a "reboil"; and to attain some particular goal other than chemical analysis on tensile properties, such as hardenability, grain size, freedom from aging, etc. MS (3b)

Rapid Determination of Oxide in Molten Steel. A. B. KINZEL, J. J. EGAN & R. J. PRICE. *Metals & Alloys,* Vol. 5, May 1934, pages 96, 105. Method described involves conversion of oxides present to Al_2O_3 by deoxidation of test ingot with Al wire. Subsequent solution in warm (at 30° C.) 30% HNO_3 leaves the Al_2O_3 unattacked. Ammonium persulphate, HCl and ashless lampblack are added during the solution to facilitate the latter stages of solution and the centrifugal separation of undissolved Al_2O_3 which is ignited in Pt dishes at 900° C. in a small muffle furnace. It is stated that the test can be carried out completely in 10 min. and results indicate close agreement with standard method. WLC (3b)

Improves Quality of Centrifugally Cast Pipe. B. K. PRICE. *Steel,* Vol. 94, Feb. 12, 1934, pages 23-25. United States Pipe & Foundry Co. is producing "super de Lavaud" pipe by preventing chilling of the Fe in casting. This is accomplished by the application of a powder with a carrier gas onto the surface of the metal mold immediately preceding contact of the Fe stream. A special method of application has been devised. Unchilled pipe is annealed at a somewhat lower temperature but for a slightly longer period than in previous practice. New pipe has greater ductility and toughness, 100% more impact resistance, and greater carrying capacity, and is more easily cut and tapped. Plant installed at Bessemer, Ala., is described. MS (3b)

Fundamentals of the Basic Process for Steel Making. A. PORTEVIN. *Metal Progress* Vol. 25, Dec. 1933, pages 48, 50. The fundamental factors in steel melting are chemical equilibrium between metal and slag, the problem of durable furnace lining, and rapid attainment of chemical equilibrium for economy. Progress in metallurgy will come from better and wider knowledge of these equilibrium conditions between slag and metal. WLC (3b)

Theoretical and Practical Study on Melting in Cupola Furnaces (Étude theorique et pratique de la Fusion aux Cubilots) ADOLPHE POUMAY, JR. *Revue de Fonderie Moderne,* Vol. 28, Mar. 10, 1934, pages 71-75; Mar. 25, 1934, pages 85-91. A correlated abstract and discussion of results of experiments in this field is given of the work of Osann, Geiger, Buzek, Piwowarsky, Cook, Hurst, Wilson, and others. Calculation of air requirement and efficiencies is discussed. Ha (3b)

Die Casting Iron and Steel. A. W. MORRIS & HERBERT R. SIMONDS. *Iron Age,* Vol. 131, June 29, 1933, pages 1028-1030, adv. sec. page 14. Describes some of the operating details and results of recent research work in the field of die casting Fe and steel. Die casting of low melting point alloys, under 1000° F., differs from those melting at from 2500 to 3000° F. Gives details of a machine developed by A. W. Morris and known as "Cast-o-matic." This machine is now in operation at a large Pennsylvania plant. Not all Fe is suitable for die casting. Electrically melted Fe is preferred. Nitridable cast Fe is successfully die cast, but with a higher % of rejections. Includes a table giving chemical composition of cast Fe which will diecast. Best material for molds has not been definitely determined, although high grade alloy is being used for camshaft molds. Experience shows that mold should be designed for bottom pouring and parting plane should be vertical. Cost of die casting of Fe will average about ½ that of a die for forging. VSP (3b)

Cast Iron Pipe Produced by Centrifugal Force (La Force Centrifuge Appliquee a la Fabrication Industrielle des Tuyaux en Fonte). A. AURELI. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, Feb. 1934, pages 52-66. Italian exchange paper presented at the Foundry Congress, Paris, 1934. Review of the three methods,—Moore, Delavaud, and Arens,—for the production of cast Fe pipe by means of centrifugal machines. Details of methods and machines, as well as comparison of Arens pipe to pit cast pipe, are given. WHS (3b)

Balanced Blast Cupola (Le Cubilot a Vent Equilibre). *La Fonderie Belge,* Vol. 2, Feb. 1933, pages 31-33. Description of cupola developed and patented by the British Cast Iron Research Association. FR (3b)

Chrysler Casts Two Cylinder Blocks in Single Mold. *Iron Age,* Vol. 131, June 15, 1933, pages 946-949. Describes a new method employed in casting cylinder blocks at the foundry of the Chrysler Corporation. Among the foremost achievements is the casting of two cylinder blocks in one mold. The essence of success in this method lies in raising the Fe to a temperature of about 2800° F. and pouring it rapidly. The Fe is melted in standard type cupolas. The air and coke used in the cupola are greater than ordinarily used. By means of this method the foundry is able to make 170 six- and eight-cylinder blocks an hour. Core making is on a scientific basis by the use of special core-blowing machines and ingenious fixtures. VSP (3b)

Use of Ferro-Chromium in the Foundries (Le ferro-chrome dans ses emplois en fonderie) *Journal du Four Electrique,* Vol. 43, Feb. 1934, pages 52-55. Chromium has a beneficial influence on physical properties of cast Fe. Addition of Cr to the cupola cannot be recommended. JDG (3b)

Continuous Moulding Machine Aids Production. *Metal Industry, N. Y.* Vol. 32, March 1934, page 97. A description is given of a setup in the Cleveland Works of the Westinghouse Electric & Manufacturing Company whereby high production is obtained. PRK (3b)

Age of Alloys Ushers in New Markets for Foundries. *Steel,* Vol. 94, Jan. 1, 1934, pages 130-131. Reviews foundry developments in 1933. These include addition of N_2 to high—Cr cast-steels; increasing use of cast alloy steels; increasing use of cast materials in automotive construction; use of alloys in malleable iron; and short cycle annealing of malleable iron. MS (3b)

Price of Liquid Iron for Castings of Variable Wall Thickness (Wie hoch stellt sich der kg—Preis des flüssigen Eisens bei Gusstücken mit verschiedenen Wandstärken). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 18, 1934, pages 116-118. Savings in cast Fe founding depend on selection of suitable pig irons with due regard to the purchasing prices and the analyses as well as composition of suitable charges. Accurate determination of melting costs and Fe losses are required for calculating Fe price. Proper relation of weights between gates, risers and pieces cast is emphasized. Further savings can be effected by using high share of scrap in charge. According to type of casting 60-70% scrap may be used. Dangerous sulphurization upon application of high percentage of cast Fe scrap can be counteracted by using up to 20% steel scrap. In melting with high percentage of steel scrap application of good coke is absolutely necessary. GN (3b)

Open Hearth Operations in Retrospect. L. F. REINARTZ. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, pages 29-30, 45. Reviews developments during 1933. There were no outstanding achievements. Considerable attention was paid to more efficient utilization of fuel, with wide-spread adoption of insulation of furnaces. Dr. Herty has made a significant contribution to control of Fe O. Much equipment was fabricated by welding and the cutting torch has speeded up repairs to furnaces and equipment. MS (3b)

Steel Desulphurization and Improved Slag Manipulation in the Coreless Induction Furnace (Stahlentschweflung und verbesserte Schlakenführung im kernlosen Induktionsofen). H. E. MARTENS. *Die Metallbörse,* Vol. 24, Jan. 13, 1934, pages 50-51. Recent advances improved the favorable production cost ratio of coreless induction furnace: electric arc furnace = 1 : 1.6 in favor of the former. The advantage of the arc furnace in regard to an easy and thorough removal of S has been abolished recently. Instead of increasing the fluorspar content in the induction furnace slag, the utilization of alkalines, preferably calcined soda, has been successful. Na-silicate is advantageously employed as solvent for the soda which dissociates at elevated temperatures. The S elimination takes place according to the following reaction: $Na_2O + FeS = Na_2S + FeO$. Soda is added gradually to check volatilization losses. EF (3b)

A Special Permanent Mold for Spinning Vessels Made of Pure Aluminum (Eine Dauersonderbauart für Reinaluminium-Spinntöpfe). H. REININGER. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 4, 1934, pages 96-97. In artificial silk production spinning vessels of highest corrosion stability are required. For this purpose pure Al (99.5% Al) is generally used. In making these Al castings, however, 2 difficulties are encountered. (1) severe piping, (2) difficult separation of gates and risers from casting. The mentioned difficulties can be overcome by described new type of permanent mold made of pearlitic cast Fe. GN (3b)

Control of the Temperature of Basic Converter Steel During its Making and Teeming (Réglage de la temperaturé de l'acier Thomas pendant son elabotion et sa coulée). H. MALCOR. *Revue de Métallurgie,* Vol. 31, Feb. 1934, pages 57-67. Even if the difference between a very hot heat and a cold heat is within 50° C. the temperature control of converter heats is important. Radiation pyrometers are preferable. They cannot give higher readings than the metal actually is and do not involve any personal error. Their disadvantage is the impossibility of taking the temperatures of small heated bodies such as teeming stream. Temperatures can be taken at the end of the blow, at the end of decarburization and on pouring in the ladle. Temperatures obtained with a typical blow are given. Factors affecting them between beginning of a blow and teeming in ingot moulds are described. The temp. rise is continuous, which checks the results of Frerich (Stahl und Eisen, Vol. 48, pages 1233-40 (1928)). As heating of the metal in a converter by artificial means is not possible, temperature regulation consists in cooling of the overheated charge. Either scrap is added or the metal is cooled by radiation. Scrap must be added before the blow is finished. Pyrometer operator tips the converter as soon as the flame is down, takes the temperature and from a properly prepared chart reads the amount of scrap to be added, if any. Cooling by radiation is done after the removal of slag. Four degrees per minute are lost under these conditions. JDG (3b)

Irregularity in Deoxidation. J. R. MILLER. *Blast Furnace and Steel Plant,* Vol. 22, Mar. 1934, page 165. Suggests that localized deoxidation under ordinary deoxidizing practice may account for the irregular behavior of the various portions of the steel when cast. MS (3b)

Some Observations on the Distribution of Non-Metallic Inclusions in Ingots. V. I. LAPITZKY & A. A. GARKUSHA. *Domez,* No. 11-12, 1933, pages 50-56. In Russian. A study of small (1.5 ton) bottom poured ingots for non metallic inclusions introduced by the erosion of the pouring gates. Visual examination of the surface was the basis of conclusions which were somewhat supported by sections taken on 1-2 ingots of each heat. Only inclusions larger than 3 mm were considered. The swirling action of the stream of steel rejects the inclusions towards the surface, as being lighter than the metal, where they are entrapped in the pasty metal. When the swirling action ceases inclusions have time to rise into the upper part of the ingot and are retained in the body of the metal principally at the bottom of the pipe. Most of them are present on the surface of the lower third of the ingots, comparatively few being observed higher. On their passage through the metal these inclusions react with deoxidation products and with MnS. When several ingots are cast on the same gate those closer to the sprue collect most of the non metallic inclusions. (3b)

Cracks in Large Malleable Castings (Les Criques dans les Pièces Importantes en Fonte pour Malléable). G. LEBRULY. *Revue de Fonderie Moderne,* Vol. 28, Feb. 25, 1934, page 50. In order to prevent cracks from occurring in large malleable castings of irregular shape they should be cooled very slowly down to the ambient temperature. Several arrangements are described to be made in case not enough cooling furnaces are available. See also W. Schyieder, Giessereipraxis, July 9, 1933. Ha (3b)

Alloys and Alloy Steel in 1933. CHARLES LONGENECKER. *Blast Furnace & Steel Plant,* Vol 22, Jan. 1934, pages 61-62. Comments on the use of alloys for cleansing and improving the quality of steel and for imparting to the finished steel certain desired physical properties. Predicts that these products will find more extensive application than they have in the past. MS (3b)

Manganese Melting Loss on the Cupola (La Porte du Manganèse au Cubilot) COLIN D. ABELL. *La Fonderie Belge,* Vol. 2, Feb. 1933, pages 34. See "Melting Losses in the Cupola Furnace—Manganese," *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 19. FR (3b)

Low Frequency Coreless Induction Furnace (Ein kernloser Induktionsofen für Drehstrom von Netzfrequenz). W. HESSENBRUCH & W. ROHN. *Stahl und Eisen,* Vol. 54, Jan. 25, 1934, pages 77-82. The design and operation of 3-5 ton motor generator set induction furnaces are described, emphasis being placed on the stirring action of the bath and on the use of refining slags. Slags become emulsified by the motion of the bath, leading to very rapid refining. On reducing the motion of the bath rapid desulphurization and deoxidation is effected. The furnaces were used in producing pure 99.95% iron and to decarburize 18-8 stainless to below 0.02% C. SE (3b)

Making Quality Steel. EMIL GATHMANN. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, page 38; Feb. 1934, page 109; Mar. 1934, page 169. Bleeding through the ingot skin, which occurs in big-end-down ingot production, may be avoided by the use of corrugated big-end-up molds. Best practice to prevent or decrease harmful splashing is to use a clean mold that is not too long and is preheated to 250°-300° F., with the molten metal teemed slowly and at as low a temperature as practical. When increasing ladle size, change should be limited as much as possible to the cross-sectional area. Most successful method of handling large heats is to use secondary, relatively shallow ladles with capacity of 5-15 tons. Experiments are being conducted on the use of big-end-up ingot molds for production of rising steel. Mold is of the standard type used for killed and rimming steels, except for the separable, chill top. This metallic top has relatively very heavy walls surrounding a chamber of comparatively small horizontal area as compared with the area of the ingot body. It should weigh enough to offset the initial pressure of gases released from the solidifying ingot. MS (3b)

Cement-Sand Cores and Molds. FEDERICO GIOLITTI. *Metal Progress,* Vol. 25, Jan. 1934, page 44. Use of high Al_2O_3 fused cements as a binder in the sand of both cores and molds is described effecting very definite savings over linseed oil binder for cores. WLC (3b)

Improved Open-Hearth Furnace. F. GIOLITTI. *Metal Progress,* Vol. 24, Oct. 1933, pages 52-53. Characteristic features of new design of open-hearth furnace described are two uptake flues through which air is blown by fans, a chamber where air and gas are completely mixed before entering the hearth, and a special arrangement of air and gas ports by which the conditions of combustion can be regulated to suit the different periods of melting and refining. 20% fuel economy is attained with the changes and output is increased. WLC (3b)

Refining Reactions in Steel Making (Les reactions d'affinage sous la fabrication de l'acier). MARCEL GUÉDRAS. *Aciers Spéciaux Métaux & Alliages,* Vol. 8, Nov. 1933, pages 371-372. This is the 3d and last installment of an article on steel making (See *Aciers Spéciaux Métaux et Alliages,* Vol. 6, Nov. 1932, page 413, and Vol. 7, April 1933, page 113). This part deals particularly with deoxidation and desulphurization in electric furnace process. Desulphurization is the resultant of the deoxidation, that is, there is an important relation between the sulphur content and that of oxide. Sulphur is partly eliminated as CaS and partly as SO_2. GTM (3b)

Cupola Charging Made Easy at Nash Motors Foundry. ROGERS FISKE. *Iron Age,* Vol. 131, June 15, 1933, pages 944-945. Method of charging cupolas at the Nash Motor Co.'s foundry, Kenosha, Wis., have been simplified, whereby 5 men do the work formerly done by 25. Describes equipment and method used. VSP (3b)

Titanium or Aluminum. N. F. Tisdale. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, page 54. Letter criticising statement of Emil Gathmann in the Nov. 1933 number that Al is best deoxidizer for making quality rimmed steels. Writer asserts that ferro-carbon-titanium is better than Al. See "Making Quality Steels," *Metals & Alloys,* Vol. 5, May 1934, page MA 180. MS (3b)

Malleable Casting by the Duplex Method. Clarence B. Teeter. *Iron Age,* Vol. 132, Dec. 28, 1933, pages 12-13, 64. Deals only with melting, molding and incidental foundry labor, and the annealing aspects of malleable Fe plant operation. Suggests how low-cost malleable castings can be made by operating small electric furnace in connection with a small cupola. Notable in the equipment proposed is a continuous annealing furnace providing for a 24-hr. annealing cycle. VSP (3b)

Low Carbon Cast Iron (Les Fontes à bas Carbone). L. Thibaud. *Revue de Fonderie Moderne,* Vol. 28, May 10, 1934, pages 127-132. Present methods of producing cast iron with 1.5-2.75% C (semi-steels) and their advantages are discussed in general. As little coke and as little air as possible in the furnace should be used for low C cast Fe. Ha (3b)

Study of a 100 Ton Stationary Open Hearth Furnace. N. I. Stupar, S. L. Levin & N. A. Serebryisky. *Domez,* No. 10, (1933), pages 14-35, No. 11-12, 1933, pages 32-49. In Russian. A very comprehensive study of two O.H. heats made in a stationary 100 ton furnace. The following factors were investigated during the heats: heat balance, air supply, temperature, air infiltration in the whole system, changes of the mixed gas used in the regenerators, hydraulic characteristics of the furnace, heat balance of separate parts of the furnace, the composition of the metallic charge, slag and melt. Detailed description of the furnace used is given. (3b)

Metallurgical Use of Calcium Phosphate. B. M. Suslov. *Metal Progress,* Vol. 23, Sept. 1933, pages 50, 52, 56. Apatite (calcium phosphate) has been used successfully for increasing the phosphorus content of low phosphorus pig iron both in the blast furnace and cupola. Its addition to electric furnace and acid open hearth charges has resulted in metal of the desired P content 0.29% to 0.38%. The use of apatite as a slag material in electric furnace melting of brasses and bronzes has been successful in keeping the metal free from O_2 and cutting the vaporization losses. WLC (3b)

Permanent Molds in Manufacturing Cream Separator Parts. Herbert R. Simonds. *Iron Age,* Vol. 131, June 15, 1933, pages 940-943. Describes the casting of gray Fe cream separator parts in permanent molds by the DeLaval Separator Co. VSP (3b)

Our Foundry Industry and Its Problems (Vaar Stöpeindustri og Dens Opgaver). John Sissener. *Teknisk Ukeblad,* Vol. 81, Apr. 12, 1934, pages 215-219. Gives the history of the Norwegian foundry industry and a theoretical discussion of the metallurgy of cast iron. Electric smelting of iron with coke instead of charcoal now undertaken in Norway, a plant at Bremanger producing 18,000 tons annually, and one at Nydalen 12,000 tons. This electric pig iron has a pearlitic structure and low carbon content; it is an excellent material for foundries as the graphite is extremely finely divided. It is remelted in cupolas where the carbon and silicon contents are regulated according to Maurer's diagram. Many Norwegian foundries are also using electric furnaces for this purpose, with excellent results. BHS (3b)

The Ternary System MnO-Al_2O_3-SiO_2. M. K. Smith. *Master's Thesis,* Carnegie Institute of Technology, Pittsburgh, 1931, 25 pages. In collaboration with U. S. Bureau of Mines, Pittsburgh Station. The possibility of obtaining slags with low melting points led to the investigation of the MnO-Al_2O_3-SiO_2 system. A section of the ternary system was chosen that would be within the range of the oxides resulting from deoxidation with various Mn, Si, and Al alloy combinations. MnO-SiO_2 slags within the range 70% MnO-30% SiO_2, and 30% MnO-70% SiO_2 were prepared and the melting temperatures determined. A slag series in the MnO-Al_2O_3-SiO_2 system within the area 70% MnO-30% SiO_2, 30% MnO-70% SiO_2, and 30% MnO-30% SiO_2-40% Al_2O_3 was likewise investigated for softening and melting temperatures, using a Pt strip micropyrometer. Slag samples were studied microscopically after quenching from definite temperatures. The melting points of all slags included in this section of the system lie between the temperatures of 1600° C. and 800° C. A ternary eutectic is indicated at 56.5% MnO, 13% Al_2O_3 and 30.5% SiO_2 having a melting point of 800° C. CWS (3b)

Instrumental Control in Metallurgical Operations (Richtlinien für die messtechnische Ueberwachung von Hüttenwerksbetrieben). B. V. Sothen. *Stahl und Eisen,* Vol. 54, May 3, 1934, pages 437-446; May 10, 1934, pages 466-470. Various pyrometers, gas meters, and other instruments in Bessemer and open-hearth plants and in rolling mills are described in considerable detail. SE (3b)

Casts All Types of Ferrous Metals. Frank G. Steinebach. *Foundry,* Sept. 1933, pages 10-12, 51. Describes the facilities of the Belle City Malleable Iron Co., Racine, Wisc., for casting of all types of steel, malleable and gray Fe castings. VSP (3b)

Melting Equipment in the Non-Ferrous Industry. R. H. Stone. *Metal Industry,* N. Y., Vol. 31, May 1933, pages 162-165; June 1933, pages 201-203; July 1933, pages 241-244. A description of furnaces is given, including their advantages and disadvantages and costs of operation. The various considerations governing the selection of melting equipment are (1) Flexibility. (2) Adapability to fuels available. (3) Quality of metal obtained and skill required. (4) Working conditions as reflected by fume losses and labor turnover. (5) Costs. Tables of costs of 10 actual installations are given. PRK (3b)

Action of Fluorspar on Open Hearth Basic Slags. Lenher Schwerin. *Metals & Alloys,* Vol. 5, Apr. 1934, pages 61-66; May 1934, pages 83-88. A correlated abstract. Fluorspar is an ore approximately 85% CaF_2, 5% or less SiO_2 and balance mainly $CaCO_3$, sp.gr. 3.18, soft, 4 Mohs, quite friable with melting point 1360-1378° C. Principal use is as a flux in basic open hearth and electric furnace slags. It decreases the viscosity of the slag thereby aiding indirectly in more effective removal of S and P by the greater reactivity of the thin slag. It is also said to form certain volatile S compounds which aid in the elimination of that element. The controversial questions discussed are the loss of F, effect upon viscosity of the slag, and upon desulphurization and dephosphorization. Although other reactions for the elimination of F may take place they are only in very limited amounts if at all and F is removed as the gas SiF_4 chiefly. The fluidity of spar slags is variously explained as due to $CaSiO_3$ formed eutectics between various silicates and fluorides, replacement of SiO_2 by Fe_2O_3, decreasing intermolecular cohesion and breaking up of molecular aggregates. The prevailing opinion seems to be that CaF_2 acts to make possible higher basicity with the same or greater fluidity making a more reactive slag and one that can be more readily removed. The high basicity favors the elimination of S and P. 64 references. WLC (3b)

Equilibria between Metals and Slags in the Melt. IV. The Equilibrium $5\,FeO + 2P \leftrightarrows P_2O_5 + Fe$ (Ueber Gleichgewichte zwischen Metalien und Schlacken im Schmelzfluss. IV. Das Gleichgewicht $5\,FeO + 2P \leftrightarrows P_2O_5 + 5Fe$). H. Schackmann & W. Krings. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 213, July 7, 1933, pages 161-179. The isotherms in the ternary system Fe-P-O were determined for the equilibria between slag and metal phase from 1450° to 1525° C. The ideal mass law is not correct for low P concentrations; beginning at 4 to 5% P the equilibrium can be expressed by $\frac{(FeO)^6 \cdot [\Sigma P]}{[Fe]^5 \cdot (P_2O_5)} = K_p$, where $K_p = 0.056$ for 1450° and $= 0.091$ for 1525° C. when the quantities are expressed in % by weight. This equilibrium is influenced as follows: alumina has no effect; SiO_2 increases K_p and facilitates reduction of P; magnesia reduces K_p and makes reduction more difficult; lime acts like magnesia but even much stronger; silicates have an influence according to their composition. 15 references. Ha (3b)

Making Quality Steels. Emil Gathmann. *Blast Furnace & Steel Plant,* Vol. 22, Apr. 1934, page 225; May 1934, pages 281, 283. Presents practical suggestions on teeming of ingots. Recommends that heats be tapped hot but teemed on the cold side through relatively large nozzles. Stopper should be opened up slowly until a pool of at least several in. has been formed in the bottom of the mold. With fully-killed steels where shrinkhead casings are used, ingots should be teemed in pairs, filling first mold until the metal rises 1-2 in. within the bottom of the casing then teeming adjacent mold in a similar manner, and then filling casing of each to the required height. Shrinkhead casings should be supported on blocks of suitable height until teeming of the ingot is finished, and the blocks removed immediately thereafter. MS (3b)

Alloy Steel Castings Regularly Made. A. W. Gregg. *Iron Age,* Vol. 132, Oct. 5, 1933, pages 15-17. Abstract of a paper presented before the Australian Bureau of Steel Manufacturers, in behalf of the American Foundrymen's Association. Discusses American developments in alloy castings. Includes a table of 15 classes of alloy steel castings regularly made in U. S., giving their chemical composition and physical properties in both the normalized and heat treated states. VSP (3b)

On the Chemical and Physical Properties of Basic Bessemer Pig Iron and Its Influence on the Operation of the Steel Plant (Ueber die chemischen und physikalischen Eigenschaften von Thomasroheisen und deren Einfluss auf die Betriebsergebnisse des Stahlwerkes). K. Eichel. *Stahl und Eisen,* Vol. 54, Mar. 8, 1934, pages 229-236. The composition of the pig iron affects its manner of oxidation; higher Si content is disadvantageous, particularly at lower temperatures. By the addition of scrap the oxidation of the metalloids is diminished. SE (3b)

Vacuum Melting of Steel (Zur Erschmelzung von Stählen im Vakuum). W. Eilender, A. von Bohlen & O. Meyer. *Archiv für das Eisenhüttenwesen,* Vol. 7, Mar. 1934, pages 493-497. A series of carbon and alloy steels were melted in a molybdenum strip wound resistance furnace under vacuum, H_2 and N_2. Commercial steel could be largely freed of O_2, N_2, and if necessary of C, and H_2 by such remelting. Higher purity than in electrolytic iron could be obtained. Curves are shown of the rate of gas evolution from the charge during heating and melting. SE (3b)

Manufacture of Automotive Piston Rings. Joseph H. Cheetham. *Iron Age,* Vol. 132, Dec. 7, 1933, pages 12-15; Dec. 14, pages 18-21; Dec. 21, pages 10-12. Describes some of the methods and principles used in design pattern-making and sand control by the Chance Co., Centralia, Mo. In Dec. 14th installment molding, pouring and machining are considered. Composition of 3/32-in. width rings of any diameter is as follows:

Fe	91.50 to 91.86%
Si	3.30 to 3.35%
P	0.50 to 0.55%
Mn	0.60 to 0.70%
Total C	3.70 to 3.80%
S	0.04 Maximum

In concluding installment the finishing operations are dealt with. VSP (3b)

Application of Thermodynamics to the Deoxidation of Liquid Steel. John Chipman. *Transactions American Society for Metals,* Vol. 22, May 1934, pages 385-446. Fundamental research into physical chemistry of steel making may follow 3 lines, physical properties such as melting points, viscosities, thermal capacities and the like of various substances and mixtures in metal and slag; equilibria relationship and energy changes; or rates of chemical reactions. Second line of attack is used and thermodynamic laws are shown to simplify calculations and study of extent of reactions. Experimental evidence is presented to show that O_2 exists in liquid steel in form of FeO or some oxide containing one atom of O_2. Evidence shows that C present in austenite and liquid Fe is Fe_3C or at least a carbide containing one atom of C. Free energies of a number of metals (dissolved in liquid steel) and their oxides are obtained from thermodynamic data and equilibrium constants for reactions involving the removal of FeO from the steel by these metals calculated. Deoxidizing powers of several elements are given. Lines for Ti, V, and Zr are estimates which may involve appreciable error but it is believed that their correct position is between Si and Al. A table summarizes the standard free energies at 1600° C. from which it is possible to calculate equilibrium constants for any reaction involving only these substances. WLC (3b)

Study of Shrinkage (Etude du Retrait). Scientific Committee of the Foundry Belgian Association. R. Berger. *La Fonderie Belge,* Vol. 3, Jan.-Feb. 1934, pages 1-11. In this last section of the article solid shrinkage is dealt with. Work of Turner reviewed. Effect of C on shrinkage as well as effect of other elements according to Wüst is studied: Total shrinkage decreases up to a C content of 1.7% and then increases. Then effect of dissolved gases and graphitization is discussed. Results of more recent studies about effect of Si, P, Mn and S are reviewed. Works of Seager and Ash and of Sauerwald are also reported. FR (3b)

Molding Devices with Mechanically Movable Pattern Parts (Formeinrichtungen mit mechanisch bewegten Modellteilen). Ferd. Brobeck. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 15, 1934, pages 153-155. Paper discusses in 4 practical examples (textile machinery and stove parts) devices developed for mechanically removing molded patterns from mold. Such molding with movable pattern parts is used to simplify molding and saves subsequent working costs due to high accuracy of parts cast. GN (3b)

Refining Alloy Steel in High Frequency Furnaces. C. A. Adams, J. C. Hodge & M. H. MacKusick. *Metal Progress,* Vol. 25, Mar. 1934, pages 15-19, 58. The electromagnetic stirring in the induction furnace may be controlled so that a slag can be carried over the entire melt. The stirring action of the metal under the slag results in greater reaction between metal and slag at their interface. Analyses show reduction of FeO, Cr_2O_3, and MnO content to negligible values by deoxidation of slags with Ca-Si. White crumbly slags similar to carbide slag of arc furnace are obtained. Induction furnace steel is not so clean as arc furnace steel and where a slag is carried inclusions are uniformly distributed. Micrographs show relative cleanliness of induction steel with and without a slag and arc steel. Tabulated analyses show very uniform conditions from heat to heat. WLC (3b)

Savings in Processing Rope Drums (Ersparnisse bei der Anfertigung von Seilscheiben). Arno. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 15, 1934, pages 167-168. Remarks on previous paper by Krebs, *Zeitschrift für die gesamte Giessereipraxis,* Vol. 53, Dec. 11, 1932, pages 489-490, *Metals & Alloys,* Vol. 4, Oct. 1933, page MA 330, *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Nov. 12, 1933, page 469. Efficient processing of such rope drums is considered from the standpoint of the pattern maker. GN (3b)

Making Super-quality Steels. *Metallurgia,* Vol. 9, Apr. 1934, pages 167-170, 182. Describes high-frequency steel-melting furnaces installed at an English plant. JLG (3b)

Investigates Effect of Gas Content on Quality of Commercial Steel. *Steel,* Vol. 94, May 14, 1934, page 49. Bureau of Standards and the Iron & Steel Division of the American Institute of Mining & Metallurgical Engineers are sponsoring an investigation of the methods for determining gases in steel, with a view towards establishing standard methods. Samples of 8 different compositions of plain-C steel have been prepared and will be distributed to more than 20 laboratories in the U. S. and foreign countries for analysis by the methods they prefer. MS (3b)

Application of Mandrels and Molds to Influence Structure and to Avoid Pipes in Iron Castings (Die Anwendung von Dornen und Kokillen zur Gefügebeeinflussung und Lunkerverhütung bei Eisenguss). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Apr. 15, 1934, page 158. Supplementary remarks on Brobeck's paper, *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 18, 1934, pages 111-114; Apr. 1, 1934, pages 133-135, that cooling molds cannot be used more than twice since formation of blowholes then results in parts thus cooled. A likely explanation of this occurrence is given. GN (3b)

The Heterogeneity of Steel Ingots. *Engineering,* Vol. 136, Sept. 22, 1933, pages 347-348. See "Fifth Report on the Heterogeneity of Steel Ingots," *Metals & Alloys,* Vol. 5, May 1934, page MA 178. LFM (3b)

Study of Shrinkage (Etude du Retrait) Scientific Committee of the Belgian Foundry Association. *La Fonderie Belge,* Vol. 3, Oct. 1933, pages 139-150. Equilibrium diagram of cast Fe is first discussed taking successively account of rapid and slow cooling. Then effect of type of crystallisation on shrinkage is dealt with. Figures are given concerning constituents of cast Fe among which are: Volume decrease of pure Fe during freezing = 1.45%. Thermal expansion coefficient per °C. for γ Fe = 0.000016, for α Fe = 0.000012, for cementite = 0.0000105, for graphite = 0.0000024. In last section of the article works of various experimentators are reported at length and discussed. FR (3b)

Conveyor Screws of Various Pitches and Diameters in Single Steel Castings. *Iron Age,* Vol. 132, Nov. 23, 1933, pages 16-17, 51. Describes a patented method of conveyor screws casting integrally from solid patterns and made in any combination of pitches, diam. and flights by the Chicago Steel Foundry Co. The screws may be cast of C steel of any analysis, of "Evansteel" for resistance to abrasion and for high strength, or of "Pyrasteel" for high temperature work. Molding equipment consists of single flask, open top and bottom. Length of a pattern depends on diam. of screw. All patterns are made of metal and accurately ground to specifications within limits of 0.002". Operations of molding a section of a screw consist of placing a bottom plate on the bench. Vent holes are pierced every 5 or 6 in. and flask is rapped by hand. Requirements as to variation in diam., pitch, etc., are met by placing in pouring line molds made from the desired pattern. Pourgates and risers are made of core-sand. VSP (3b)

Calcium-Silicide (Le silico-calcium). *Journal du Four Electrique,* Vol. 43, Apr. 1934, page 127. These alloys having an average composition: C 1.2-1.6%, Si 58-61%, Mn 0.006-0.007%, Ca 29-31% are prepared by a reduction of SiO_2 and CaO in an electric furnace in the presence of C. It acts as a strong deoxidizer and a good remover of S. Low melting point of the products of deoxidation obtained with its use produces cleaner steel. The alloy added to the ladle kills the steel better than 75% Fe-Si. No Al is required when it is used for deoxidation. JDG (3b)

Processesing of Core Plates and Drying Pans (Herstellung von Kernplatten und Trockenschalen). E. Eiter. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 4, 1934, pages 91-94; Apr. 1, 1934, pages 139-140. Paper first discusses at length general manufacturing procedure of core plates and core drying pans made on core molding machines, and then considers in detail method adopted in making core for parted pulley and oil cores for bottom bushing of bearing. GN (3b)

The Application of Mandrels and Molds to Influence Structure and to Avoid Pipes in Iron Castings (Die Anwendung von Dornen und Kokillen zur Gefügebeeinflussung und Lunkerverhütung bei Eisenguss). Fritz Brobeck. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 18, 1934, pages 111-114; Apr. 1, 1934, pages 133-135. Application of cooling mandrels and molds are the most effective means to counteract pipe formation in castings. In using these remedies the cross-sectional ratio of mandrel and surrounding Fe mass is of prime importance. Practical experience shows, in casting pulleys, for instance, that effect of cooling mandrel is best when diameter of mandrel is about 1/3 of that of hub. Larger mandrels must possess core to attain proper cooling conditions. In case that disproportion exists between mandrel and surrounding Fe mass, sound casting can be processed, nevertheless, by using a hollow mandrel through which compressed air is ventilated during casting. As facing material of mandrels a mixture of debased alcohol and charcoal soot is used. Before applying facing material mandrel must be clean and absolutely free of rust. Mandrels to be used in wet sand molds should be inserted only shortly before casting. Mandrels coated with oil sand should not be used since castings with blowholes then frequently result. For certain types of castings disk molds are best used instead of mandrels. Such disk molds are applied, for instance, in casting hand wheels, pulleys and similar parts. In large castings it is advisable to arrange instead of one cooling mold several small ones separated by interspaces. Failures due to improper arrangement of molds are discussed. GN (3b)

Modern Metallurgy—A Factor in the Jobbing Iron Foundry. A. C. Denison, *Iron Age,* Vol. 132, July 6, 1933, pages 15, 68. This article is not presented primarily to boost wider use of expensive alloys, although they have their place and help meet many problems. There are other cheaper alloys such as alloys of Mn and Si. Study of the effect of these on basically good Fe will solve the requirements of many types of castings and give a flexibility of Fe control essential to good jobbing casting practice that will meet a large per cent of requirements efficiently. Intelligent use of modern metallurgy results from careful study of product under microscope, constant checking of physical properties, records of casting service and accumulated experience based on these observations. VSP (3b)

Cast Steel in Europe and America. Pat Dwyer. *Foundry,* Vol. 61, Aug. 1933, pages 19-20, 49, 51; Sept. 1933, pages 22-23, 62; Oct. 1933, pages 17-18, 58, 60. Review of the findings of Capt. Louis Shane on his visit to a number of European steel foundries as a preliminary step prior to conducting an investigation on the production of perfect castings by the U. S. navy dept. Differences in technique varied as widely as the number of foundries, but methods in all successful foundries are basically the same. Much attention is paid to fluidity of metal. Preference is shown for the high C steels. No fast rule was found covering alternative use of internal chills and large risers. Every casting is annealed at least once. Annealing temperatures range between 840° C. and 950° C. for C steels and between 1000° C. and 1050° C. for corrosion resistant steels. *Chamotte* is mostly used for facing molds, while in Britain a similar mixture known as *compo* is used. With exception of cleaning corrosion resistant steels, pickling is not employed to any great extent. Sept. and Oct. installments give comments of a number of individuals familiar with practice in Europe and America. VSP (3b)

Making the Ford Cast Alloy Crankshafts. Pat Dwyer. *Steel,* Vol. 94, Mar. 19, 1934, pages 25-27, 53. Crank-shafts now used by Ford are made of ferrous alloy containing 1.25-1.40% C, 0.50-0.60% Mn, 1.90-2.10% Si, 0.35-0.40% Cr, 2.50-2.75% Cu, 0.10% max. P, and 0.06% max. S. Metal charge composed of 50% steel scrap and 50% return crank-shaft scrap, is melted in a cupola and tapped into an air furnace, from which the metal is drawn off as required. In effect, the air furnace is like a small continuous open-hearth furnace. Shafts are cast vertically, 4 at a time, in molds made up of 16 stacked flat core sections. While a total of 421 lbs. of metal is poured in each mold, the 4 clean castings weigh only 260 lbs. Shafts are heated in a furnace to 1450° F. and are allowed to soak for an hour. They are air cooled to 800° F., then placed in another furnace where the first treatment is repeated. They are air cooled rapidly to 800° F., then allowed to cool slowly to room temperature. Brinell hardness of the heat-treated shaft averages 302 and is uniform throughout. The cast shafts are lighter than the forged steel shafts and are superior in resistance to torsion and fatigue. MS (3b)

Processing Method of Reinforced Patterns. Cast Iron or Welded Construction? (Verfahren zur Herstellung verstärkter Modelle für die gleichzeitige Gewinnung von Form und Kern. Gusseisen oder geschweisste Konstruktion?). F. Brobeck. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Mar. 4, 1934, pages 101-103. By devising described special molding equipment it was possible to make cast Fe boxes cheaper than by welding. The procedure is considered in detail. GN (3b)

Critical Studies of a Modified Ledebur Method for Determination of Oxygen in Steel, II. T. E. Brower, B. M. Larsen & W. E. Shenk. *Metals Technology,* Apr. 1934, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 549. 18 pages. It was found that at 1100° C. H slowly reduced SiO_2 in the presence of Fe and influenced O determinations made by the Ledebur method. To obviate this a method was developed for making the Ledebur analysis in an induction furnace. A sample in the form of turnings was heated in an Invar basket in a SiO_2 tube, the SiO_2 tube remaining cool while the sample was heated to 1100° C. A 1.5-KW vacuum-tube oscillator was used for obtaining the required current. In making an analysis the tube and sample were first heated in H to 530-550° C. for 90-110 min. to remove H_2O from the tube and H_2O and O from the surface of the sample. The sample was then heated to 1130-1160° C. for 110-130 min. and the H_2O formed in the H stream determined from the increase in weight of a P_2O_5 tube, a catalyst being used to convert CO_2 and CO to CH_4 and H_2O. Results obtained with samples deoxidized by various methods indicated that the values obtained were for O present in FeO present in oxide or in silicate inclusions. As the time at 1130-1160° C. was increased above 2 hr. SiO_2 and MnO were slowly reduced. For a 2-hr. heating in H at 1130° C. the O obtained from reduction of SiO_2, MnO, Al_2O_3, and ZrO_2 was negligible. Experiments with strips of different thicknesses proved that O came out by a diffusion process, since the actual rates of extraction were inversely proportional to the square of the thickness of the metal. Carburizing did not increase the FeO content of steel. 10 references. JLG (3b)

Producing Small Steel Castings. Ralph Burke. *Foundry,* Vol. 61, Oct. 1933, pages 22-23, 52, 54; Dec. 1933, pages 18-19, 50-51. Discusses the importance of molding sand, especially green sand, in production of steel castings. To meet present day competition, steel casting must be strong enough to do all that is required of it in finished product. In making suitable molding sand the mixture should contain definite proportions of binders and H_2O, also definite amounts of sands of known grain size and be milled to a uniform and specified moisture content, permeability and bond. Major portion of casting defects, particularly dirt, sponginess, pin-holes and surface defects are traceable to condition of molding sand. These troubles largely are due to condition of sand at and near the gate. Gates must be designed to allow metal to enter mold with minimum of agitation and without a squirt. Junction of gate with casting should be long and narrow. Horn gate should be avoided. Illustrates the principle of correct design of gate as it enters the casting. Runner cup must be placed so hole matches the down gate in the cape. For small castings gating in the head is satisfactory. VSP (3b)

Operation of a Shallow Hearth Mixer in the Centrifugal Sand Casting of Pipe (Betriebsergebnisse eines Flachherdmischers beim Sandschleuderguss von Muffenrohren). E. Bertram. *Stahl und Eisen,* Vol. 54, Feb. 8, 1934, pages 125-132. The operation of a shallow hearth mixer and of the centrifugal sand casting of pipe is described. A shallow hearth mixer is stated to give a very uniformly superheated cast-iron. SE (3b)

The Basis of Desulphurization of Pig Iron and Steel (Ueber die Grundlagen der Entschwefelung von Roheisen und Stahl). P. Bardenheuer & W. Geller, *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 16, No. 7, 1934, pages 77-91. Methods and processes used for desulphurization and their theoretical principles are discussed in general and practical experiences compared. Lime is superior to Mn for desulphurization with basic slags. Desulphurization with alumina is not possible. 42 references. Ha (3b)

WORKING OF METALS & ALLOYS (4)

Considering Design from the Production Standpoint. Part IV. Holes. HAROLD F. SHEPHERD. *Machine Design,* Vol. 5, Mar. 1933, pages 30-33. **Part V. Cylindrical Work.** Apr. 1933, pages 31-33. **Part VI. Flat Surfaces.** May 1933, pages 29-31. **Part VII. Die Casting.** HAROLD F. SHEPHERD & W. J. DURING. June 1933, pages 18-21. **Part VIII. Hot and Cold Forming.** HAROLD F. SHEPHERD. July 1933, pages 27-30. **Part IX. Drawing, Extruding, Pressing.** Aug. 1933, pages 30-33. **Part X. Materials.** Sept. 1933, pages 25-27. Recent developments in these production methods are discussed and illustrated. The original series of articles must be consulted. WH (4)

Plastic Forming of Metals. ERICH SIEBEL. *Steel,* Vol. 93, Oct. 16, 1933, pages 23-25; Oct. 23, 1933, pages 37-38, 40; Oct. 30, 1933, pages 32-34; Nov. 6, 1933, pages 36, 38, 41-42; Nov. 13, 1933, pages 26, 28; Nov. 20, 1933, pages 28, 30, 32, 34; Nov. 27, 1933, pages 27-29; Dec. 4, 1933, pages 30, 33-34; Dec. 11, 1933, pages 28, 31-32, 34; Dec. 18, 1933, pages 26-28, 30, 32; Dec. 25, 1933, pages 24, 44-45; Vol. 94, Jan. 8, 1934, pages 24-25, 43; Jan. 15, 1934, pages 27-29; Jan. 22, 1934, pages 30-32; Jan. 29, 1934, pages 27-28, 30; Feb. 5, 1934, pages 36, 39-40; Feb. 12, 1934, pages 29-30, 32; Feb. 19, 1934, pages 35-37; Feb. 26, 1934, pages 27-28, 30, 32; Mar. 5, 1934, pages 37-38, 41-42; Mar. 12, 1934, pages 34-35, 37-38; Mar. 19, 1934, pages 28-30; Mar. 26, 1934, pages 38-39, 41; Apr. 2, 1934, pages 25-26, 28; Apr. 9, 1934, pages 40, 43-44; Apr. 16, 1934, pages 42, 44, 46; Apr. 23, 1934, pages 40, 42, 45; Apr. 30, 1934, pages 39-40, 42; May 7, 1934, pages 51-52, 54. Translation of author's "Die Formgebung im bildsamen Zustande; theoretische Grundlagen der technischen Formgebungsverfahren." For review of German work, see *Metals & Alloys,* Vol. 4, Feb. 1933, page MA 44. MS (4)

Rolling (4a)

RICHARD RIMBACH, SECTION EDITOR

Rolling Mill Practice (Walzwerkswesen). Vol. II. J. PUPPE & G. STAUBER. Verlag Stahleisen, Düsseldorf, 1934. Cloth, 8 x 11 inches, 524 pages. Price 110 RM.

Modern rolling mills for heavy and light sections for plates, rails, strip, sheet, etc., are described, with some attention to historical development. Many American installations are included. Mechanical drawings of mill layouts, illustrations of sections at each pass, details of cooling beds, shears, etc., etc., are given in great profusion.

The book is an extremely expensive one, but of a type that is very costly to prepare and produce. Rolling mill engineers will find it of much interest for its many details on mechanical design. H. W. Gillett (4a)—B—

Calculation of the Effect of Individual Passes in the Rolling of Freely Widening Sections (Zeichnerische Bestimmung der Stichfolge beim Walzen frei breitender Querschnitte). O. EMICKE & H. ALLHAUSEN. *Stahl und Eisen,* Vol. 54, May 17, 1934, pages 492-500. Calculations are described by which the relations between the initial and final rolled section and the number of passes and the rolling pressure are expressed graphically. These graphs can be used as an aid in roll design. SE (4a)

Effect of Composition of the Steel on the Work Expended and Resistance to Deformation in Rolling Ingots (Einfluss der Stahlzusammensetzung auf der Arbeitsaufwand und den Formänderungswiderstand beim Blockwalzen). H. HOFF & T. DAHL. *Stahl und Eisen,* Vol. 54, Mar. 22, 1934, pages 277-281. In rolling C, Cr-Mo, and Cr-Ni steel ingots, the work required was about 10% and 23% greater for the Cr-Mo and Cr-Ni steel respectively over C steel; the resistance to deformation was 10% and 45% greater respectively. SE (4a)

Roll Pass Design in a Russian Mill. FRITZ BRAUN & HEINRICH KETTLER. *Blast Furnace & Steel Plant,* Vol. 22, May 1934, pages 263-267. See "Rolling Rails in a Russian Mill," *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 129. MS (4a)

Straightening Large Beams. W. TRINKS. *Blast Furnace & Steel Plant,* Vol. 22, Jan. 1934, page 39. In the United States, rails and large beams, particularly wide-flange beams, are straightened under the gag press. In Europe, rails and medium-sized channels are usually straightened in roller straighteners. Suggestion is made occasionally in the United States that roller straightener be used for large beams. Calculation shows that this would not be feasible. A. H. Emery proposed clamping the beam between very rigid straight dies constituting the columns of a press and subjecting the clamped beam to a longitudinal thrust. This has never been tried on a full-size scale. MS (4a)

Tension in Continuous Mills. W. TRINKS. *Blast Furnace & Steel Plant,* Vol. 22, Mar. 1934, page 171. Shows that tension between the stands of a continuous mill (which at first thought seems desirable) reduces the yield. Ends of bar are rolled without tension, resulting in thicker sections than those under tension, and have to be discarded. MS (4a)

Three-High Breakdown Mill. W. TRINKS. *Blast Furnace & Steel Plant,* Vol. 22, Feb. 1934, page 111; Mar. 1934, page 171. In 3-high breakdown mills with bottom roll drive, the drafts in the top passes are usually made much lighter than those in the bottom passes to avoid stalling of the top and middle rolls. Analysis of the force diagrams shows that if the friction of the top roll is reduced to a very low value, heavy drafts can be taken in the top pass without recourse to the expedient of driving the top roll from the bottom one by means of a friction-clutch. Reducing degree of polish of the rolls permits heavier drafts. MS (4a)

Notes on Roll Grinders. W. TRINKS. *Blast Furnace & Steel Plant,* Vol. 22, May, 1934, page 283. Deals with chatter-marks on rolls. This difficulty has been overcome by the use of an improved lathe bearing for the grinding-wheel and of multiple V belts for the drive. MS (4a)

Kinks from European Mills. W. TRINKS. *Blast Furnace & Steel Plant,* Vol. 22, Apr. 1934, page 227. Describes methods observed by the author in European steel-works and for which he found no counterpart in the U. S. These include lubrication of finishing passes by tar or heavy oil; use of a telescoping boot between the bearing of the toproll and the nut of blooming-mill screws; in seamless tube making, use of a hydraulic press to punch a hole through the round ingot, before the latter went to the Mannesmann mill; making expanding-mill mandrel of the tension type; and driving of hot-saws by an electric motor on the same shaft, through a cam control. MS (4a)

Effect of Friction and Dimensions of the Sections on the Flow of Material in Rolling (Ueber den Einfluss der Reibung und der Querschnittsabmessungen auf den Materialfluss beim Walzen). ERICH SIEBEL & E. OSENBERG. *Mitteilungen Kaiser-Wilhelm-Institut für Eisenforschung,* Düsseldorf, Vol. 16, No. 4, 1934, pages 33-50. Experience has shown that metals do not always deform in the same manner under the same geometrical conditions; from experiments it was found that friction is the principal cause for this diversity of behavior under plastic deformation. The influence of friction in rolling becomes the greater the thinner the material is in proportion to the dimensions of the rolls. Smooth roll surfaces and good lubrication contribute largely to elimination of difficulties due to friction. 18 references. Ha (4a)

Seamless Tubes Hot Rolled to Size by New Type Mill. W. G. GUDE. *Steel,* Vol. 94, Apr. 9, 1934, pages 48-49. Describes operation of Foren-type mill at Globe Steel Tubes Co., Milwaukee, Wis. Heated billets pass through a piercing mill, and before billet is served to the mill proper, a ground and hardened alloy steel mandrel is inserted in the pierced blank. This mandrel travels with the tube and acts as a solid base during the rolling. Billet and bar pass through 5 stands of squeezer rolls just prior to entering rolling-mill. There are 21 stands in the rolling-mill, each individually motor driven and synchronized to accommodate variations in speed and to prevent any slack from developing in the work. Pairs of rolls are located at 22.5° on each side of the horizontal and vertical planes. Production is at high speed, the mill easily turning out 6 tubes, 40 ft. long, per min. Tube is stripped from the mandrel by 3 sets of pinch rolls while bar is held by a set of jaws. Principal features claimed are that all sizes of tubes may be finished by hot rolling, practically any length can be rolled, grain structure and surface quality are improved, and eccentricity is minimized. MS (4a)

Single-Stand Continuous Rolling of Hot and Cold Strip. A. P. STECKEL. *Iron Age,* Vol. 131, May 18, 1933, page 779, adv. sec. page 12. Abstract of paper read before the Cleveland section of the association of Iron and Steel Electrical Engineers. Discusses the use of one single four-high reversing stand to do the entire work of the continuous mill in rolling such material as strip. In hot rolling the capacity of such a mill is in excess of 10 tons per hr. per ft. of width, figures applying to steel rolled to No. 12 gage for an initial slab thickness of 4 to 5 in. In cold rolling with Steckel mill, speeds are of the order of 1500 ft. per min. 18% Cr-8% Ni rustless alloys are rolled between 3 in. rolls from initial thickness of ¼ in. and a width of 18 in. down to 0.018 in. without an intermediate anneal. Making tin plate, the practice is to provide for 15% reduction on every pass and in some cases as high as 30%. Cost is low. VSP (4a)

Records Roll Pressure Electrically. *Iron Age,* Vol. 133, May 17, 1934, pages 16-17. Describes and illustrates a recording instrument for giving instantaneous and also continuous indications of pressures in rolling mill operations. Pressure developed causes a movement of a column of Hg, this in turn closes an electric circuit in which there is an electric lamp. Illumination of a given lamp becomes a measure of the height of Hg and therefore the amount of pressure. In addition pressure fluctuations are recorded. Device is placed between upper roll and a counter bearing. Developed by Losenhausenwerk, A.G., Germany. VSP (4a)

Forging & Extruding (4b)

A. W. DEMMLER, SECTION EDITOR

Technique of Heavy Forging. RONALD BENSON. *Heat Treating & Forging,* Vol. 20, Jan. 1934, pages 29-31, 34; Mar. 1934, pages 121-124; Apr. 1934, pages 182-184. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 130. MS (4b)

The Forgeability of High-Speed Steel. O. W. ELLIS & J. BARBEAU. *Metals & Alloys,* Vol. 4, Nov. 1933, pages 171-174. Forgeability-temperature relationships for a high speed steel, (C 0.70%, Cr 3.69%, W 19.23%, V 1.12%), are shown graphically by plotting percent reduction of height of a "normal" specimen for a standard blow against temperature; a "normal" specimen is one having the same height as diameter. Because of increased resistance to deformation at 840°-850° C., the authors conclude that the alloy elements present must undergo some rearrangement resulting in greater density at this temperature. An equation previously given by the senior author, involving energy required to produce a definite percentage reduction in height of a "normal" specimen is shown to hold only when the deformation is small. WLC (4b)

Extruded Steel Forgings—Their Production, Use. EDWIN F. CONE. *Steel,* Vol. 94, May 7, 1934, pages 25-27. Describes production of plain-C and alloy steel extruded forgings in the specialty forge department of the Bethlehem Steel Co. Hot metal is pierced in vertical hydraulic presses. Depending on product to be made, punched piece then may be slipped over a long mandrel and hydraulically pushed through a series of drawing rings on a horizontal drawbench. Forging dies are generally of cupola gray-Fe, high in graphite; they are water cooled, and open at the top. Among the products are valves and tool joints for the oil industry, airplane-engine cylinder sleeves, trunk pistons for locomotive boosters, hub forgings and brake drums for trucks, tubing for bearing-metal races, etc. MS (4b)

Drawing & Stamping (4c)

Influence of the Reduction in Cold Drawing on the Internal Stresses in Round Rods (Einfluss der Querschnittsverminderung beim Kaltziehen auf die Spannungen in Rundstangen). H. BÜHLER & H. BUCHOLTZ. *Archiv für das Eisenhüttenwesen,* Vol. 7, Jan. 1934, pages 427-430. Tensile stresses arise at the surface after cold reductions of about 1% and higher, e.g., of about 2 to 6%, accompanied of course by compressive stresses at the core. With reductions of less than 1%, however, compressive stresses form at the surface and tensile stresses at the core. SE (4c)

Recent Wire Mills (Neuzeitliche Metalldrahtzieherein). CH. BERNHOEFT. *Zeitschrift für Metallkunde,* Vol. 26, Jan. 1934, pages 19-23. A general description of modern technique in drawing fine wires (under 2.5 mm. diameter). RFM (4c)

Work Economy in Direct and Indirect Wire Cutting Presses (Kraftersparnis zwischen direktem und indirektem Strangpressen). CH. BERNHOEFT. *Zeitschrift für Metallkunde,* Vol. 25, Dec. 1933, pages 315-316. Data are given on press pressure against final diameter for bars of different length. It is shown that only the bar length and the nature of the alloy are important while the final diameter is without influence. RFM (4c)

Effect of Cold Working on Metals (Die Wirkung der Kaltbearbeitung auf metallische Werkstoffe). GUSTAV TAMMANN. *Forschungen & Fortschritte,* Vol. 10, Apr. 1, 1934, pages 128-129. Electric resistance, thermo-electric force, hardness and elastic properties of Cu recover from cold working in the same temperature range of 100°-200° C. whereby the potential energy induced by cold working is liberated as thermal energy. EF (4c)

Effect of a Backward Pull upon the Tension Required to Draw Wire. F. C. THOMPSON. *Sheet Metal Industries,* Vol. 7, Dec. 1933, pages 453-454. See *Metals & Alloys,* Vol. 5, May 1934, page MA 182. AWM (4c)

Fluting in Annealed Sheet Steel and Its Elimination. WAYNE A. SISSON & GEORGE L. CLARK. *Metals & Alloys,* Vol. 5, May 1934, pages 103-105. Three methods of eliminating the sharp bend characteristic called "fluting" in sheet steel are discussed. The "skin" pass does not materially alter the physical properties of workability. Quenching from 700° C. lowers the forming ability and hardens the materials. The production of a controlled (large) grain size by giving a large reduction, annealing, small reduction and final anneal results in good forming ability and the softest product. WLC (4c)

Variety of Small Stampings Used in Luggage Hardware. W. G. GUDE. *Steel,* Vol. 94, May 7, 1934, pages 39-40. Description of the facilities of the Milwaukee Stamping Co., Milwaukee, Wis., for the production of a variety of large and small stampings and assemblies of steel and other metals. Frame of Gladstone bag is fabricated from hot-rolled strip steel, while the attachments are stamped from cold-rolled strip. Solid bronze is used for hardware on most expensive bags. MS (4c)

Instruments for Measuring the Thickness of Rolled Products (Sheets, Strip Steel, Strip Brass, etc.) (Messgeräte für die Prüfung der Dicke von Walzgütern (Bleche, Bandstahl, Bandmessing usw.)). O. SCHLIPPE. *Metalwirtschaft,* Vol. 13, Mar. 9, 1934, pages 169-170. An instrument which indicates the thickness of strip metals at 2 points across their width and a larger one for sheet metals are described. The metal can be passed through the instruments while being rolled and continuous readings taken. Another instrument is used to accurately
1
check rolls for straightness and trueness with respect to their bearings. CEM (4a)

Machining (4d)

H. W. GRAHAM, SECTION EDITOR

Diamond-Impregnated Carboloy. GEORGE F. TAYLOR. *General Electric Review,* Vol. 37, Feb. 1934, pages 97-99. The diamond has ideal properties for an abrasive material and for drilling. About half of the diamonds produced are suitable for gems, the other half is used in industry as grinding-wheel dressers, earth drills, wire-drawing dies, stone saws, abrasive powders, lathe and boring tools, glass cut-
2
ters, etc. Methods of mounting diamonds in holders and their shortcomings are discussed. Under certain temperature conditions cemented carbide, such as carboloy, has a peculiar affinity for diamond and is well adapted for mounting. The coefficients of expansion of diamond and carboloy are very close together. Small fragments of diamond can be successfully embedded in the carboloy. Careful tests have shown savings of about 25% in the cost of wheel dressing with diamond impregnated carboloy. A better finish is also obtained. CBJ (4d)

Fine Machining of Non-ferrous Metals (Feinstbearbeitung von Nichteisenmetallen). O. SCHLIPPE. *Metallwirtschaft,* Vol. 13, Jan. 26, 1934, pages 61-67. Diamonds are extensively used for finish machining non-ferrous metals when a very smooth surface with a high polish is desired. They are too brittle to use for rough machining with heavy cuts. The diamond can retain a much sharper cutting edge than tungsten carbide tools. A rigid mounting for the diamond is important. Mechanical
3
holders have now largely replaced the former practice of soldering the diamond to the holder which had a tendency to strain it. The highest polish is obtained if the diamond tool presses the work in addition to cutting it. Higher speeds are used than with steel tools, 250 to 700 m./min., and smaller feeds, .015 to .066 mm./revolution. It is essential that the machine be free from vibration when these high speeds are used. Diamonds are used mostly for soft metals, such as bearing metals, copper, Al alloys, and for hard rubber and bakelite. Several machines designed especially for use with diamonds are described. Lapping with grinding compounds is used for obtaining good bearings more on steel than on non-ferrous metals as they are liable to be scored. However, there are press polishing processes which
4
are suitable for bronze and Al alloys. CEM (4d)

Jigs and Tools. C. T. SKIPPER. *Machinery,* London, Vol. 43, Mar. 8, 1934, pages 683-686. Detailed discussion of jig design and tool design with consideration of feeds and speeds, admissible cuts for various metals, and the strength condition of the work to be machined. Kz (4d)

Machining Stainless Steel. W. SEDGEWICK. *Machinery,* London, Vol. 43, Oct. 19, 1933, page 89. Chief causes of trouble in machining stainless steel to a high degree of accuracy and finish are: (1) the severe abrasive action which quickly wears away the edge of a tool, (2) the tendency of the steel to "pick up" and cause a rough finish. To overcome these difficulties, rules concerning tools and
5
operation of machines are discussed. Kz (4d)

Chevrolet Makes Ring Gears in World's Largest Gear Cutting Plant. BURNHAM FINNEY. *Iron Age,* Vol. 132, Nov. 30, 1933, pages 12-15. Describes heat treating, machinery, and inspection processes used at the plant of the Chevrolet Motor Co. VSP (4d)

Making Chevrolet Transmission Gears. BURNHAM FINNEY. *Iron Age,* Vol. 133, Jan. 11, 1934, pages 10-13; Jan. 18, 1934, pages 12-15. Describes the manufacture of gears at the Toledo, O. plant of Chevrolet Motor Co. Deals with the machining of the gears and the subsequent heat treatment and testing. VSP (4d)

Surface Roughness Needs Attention. E. J. ABBOTT. *Machine Design,* Vol. 6,
6
May 1934, page 31. Discusses the profilograph developed in the physics laboratories of the University of Michigan with the object of determining the roughness of surfaces. The device consists essentially of a means of tracing over the surface with a sharp diamond point the motions of which are communicated to a mirror and photographic paper. Typical records made by the profilograph on surface finishes of a lapped, ground, finish milled and diamond bored steel are presented revealing irregularities of heights down to 10-20 millionths of an inch. The curves prove that the profiles of various machined finishes vary widely not only in size and irregularities but also in character. WH (4d)

Behavior of Metals During Cutting Investigated at Length. *Iron Age,* Vol. 132, July 6, 1933, pages 31-32. Brief abstracts of papers read before the shop practice division of the American Society of Mechanical Engineers. Friedrich Schwerd de-
7
scribed the elaborate research work covering actual conditions during cutting of metals. In general he was trying to determine 3 features: (1) How to obtain the best finish; (2) What was needed to give the closest tolerance; and (3) How to do cutting most economically. Other papers before this division were by O. W. Boston and C. E. Kraus on Elements of Milling: Three types of cemented-carbides by Malcolm F. Judkins and William C. Uecker; and X-ray inspection of welds by Herbert R. Isenburger. VSP (4d)

Machinability of Single Crystals of Tin (Die Zerspanbarkeit von Zinneinkristallen). ERICH SCHMID. *Metallwirtschaft,* Vol. 13, April 27, 1934, pages 301-304. Flat Sn single crystals were prepared in a graphite mold and their crystallographic axes determined by X-ray examination. They were attached to a ground steel plate
8
and machined with the Leyensetter apparatus, by which a constant force is applied and the machinability measured by the size of the chips. From this the work required to remove 1 cm.^{3} of metal was calculated. The results were reproducible in crystals of the same orientation within 1 to 3%. The machinability in different crystals varied from 2.1×10^9 to 3.85×10^9 ergs/cm.^{3} with an average of 2.74×10^9, comparing with 3.09×10^9 for polycrystalline Sn. The results are shown graphically. CEM (4d)

Machine Tool Development with Special Reference to the Use of Carbide Tools and Hydraulic Mechanisms. J. D. SCAIFE. *Institution of Production Engineers,* Vol. 12, Sept. 1933, pages 369-397. Includes discussion paper presented to the Institution of Production Engineers, Luton and Coventry Sections. After deal-
9
ing with the characteristics and efficiency of carbide tools the author discusses the influence which the new cutting materials have on machine design. The main points of design which have received special consideration are: speed (range and variability), rigidity, balance of high speed shafts, main spindle bearings, swarf handlings or controlling and slide coverings. Dealing with the application of hydraulic mechanisms to various machine tools their design and features are critically discussed. Kz (4d)

Types and Uses of Cutting Oils. MAURICE RESWICK. *Iron Age,* Vol. 132, Dec. 7, 1933, pages 22-24. Principal functions of good cutting oils are: (1) To lubricate contact points, reducing friction and frictional heat and lowering power consumption; (2) to carry away and dissipate heat from tool and adjacent parts; (3) to penetrate into crack of metal above cutting edge; (4) to act as a flushing oil; (5) to leave a rust preventative coating on work piece; and (6) to give added
10
finish which reduces time in grinding. Describes briefly the characteristics and uses of the following varieties: (1) Straight mineral lubricating oils; (2) Mineral oils compounded with lard oil; (3) Sulphurized mineral oils; (4) Sulphurized mineral oil with lard oil; and (5) Soluble or emulsifying oils. Includes information relating to the checking of strength, straining, filtering, and prevention of skin infections. VSP (4d)

HEAT TREATMENT (5)

O. E. HARDER, SECTION EDITOR

Heat Treatment of Metals. Vols. I and II. ORIN W. McMULLAN. Interna-
1 tional Textbook Company, Scranton, Pa., 1933. Fabrikoid, 5 x 7½ inches, 77 and 60 pages resp. Price Vol. I, $1.85, Vol. II, $1.75.

Some of the broad principles governing the choice and operation of heat-treating equipment are set forth in the introduction. A simplified iron-carbon diagram, a brief description of lattice structure, a description of Ar", a list of S.A.E. carbon steels and a discussion of the structures obtained by heat treatment follow.

Case hardening, normality and grain size, with some comment on nitriding come next in regard to carbon steels, followed by a discussion of alloy carburizing steels and S. A. E. alloy steels in general, completing vol. 1.

Vol. 2 covers tools and dies, starting with carbon steel and working up through high speed. Heat treatment of steel castings, structure and properties of gray and malleable iron come next. Another iron carbon diagram covering the cast iron
2 range is included. It is interesting to note that the author does not bother his reader with the iron graphite diagram, but accounts for graphite on the basis of decomposition of cementite. Alloy cast irons and the quenching and tempering of cast iron are discussed.

Deep etching, hardness determination, tensile, torsion, endurance, impact testing, radiographic inspection, etc., are discussed. Cleaning, pickling, rust proofing and coloring are briefly dealt with.

Non-ferrous metals are then taken up, typical equilibrium diagrams shown, softening by annealing, precipitation hardening of duralumin, and heat-treatment of aluminum bronze discussed, with some comment on castings, bearing metals, etc.

The volumes are simply written, authoritative and concise. They are obviously written for the practical man who wants to understand enough of the "why" to ex-
3 plain the "how," with the theory neither passed over as too tough for him to grasp nor over-emphasized. It is brought in with good perspective and in an unstrained manner. The little volumes would make a better college textbook than many now in use and will admirably serve their special purpose, home study.

The volumes are well printed and bound. Lack of an alphabetical index and a list of larger textbooks for further study are omissions that might have been supplied to advantage. There are some cases where brevity is carried so far that the picture is not very clear, or where allusion is made to metallurgical phenomena that are not described in enough detail for the reader to grasp, so that some reference to other authorities would be in order. But on the whole, the condensation has not been carried so far as to make the discussion cryptic. This is a difficult type of book to
4 write, but the job is well done. H. W. Gillett (5)—B—

Modern Heat Treatment. HENRY TOPLIS. *Institution of Production Engineers,* Vol. 12, Aug. 1933, pages 335-368. Includes discussion. Paper presented to the Institution of Production Engineers, Luton and Glasgow Section. As a necessary apparatus for pyrometer and recorder checking is given: (1) a standard indicator; (2) a millivolt box; (3) a salt bath giving the fusion point of common salt. Dealing with furnaces and their working thermal efficiency, the advantages and disadvantages of gas, electricity and oil as heating agents are discussed and examples are mentioned. Carburizing: compounds and boxes are critically discussed with regard to efficiency and cost of operation. Three methods for local protection aganst carburising are dealt with (1) Machining out of the carburised
5 portion before final hardening; (2) Letting down by lead or salt bath after hardening; (3) Prevention of local carburising by clay-proprietary anti-carburizer or coppering. Carburizing temperatures, quenching from carburizing and quenching media are discussed. Dealing with the nitriding process, flame hardening, low temperature tempering and reheating in salts are discussed as well as liquid salt baths. Speaking of cyanide hardening the skin compound practice and the use of low grade cyanide baths as reheating agents are touched upon. Methods of heat treatment of Al alloys which are discussed are the solution treatment and the precipitation treatment. Quenching of Al alloys after heat treatment is touched upon. Remarkable features of the paper are the tables and practical examples which are discussed. JCC & Kz (5)

Relation of Temper Colors to Temperatures. T. N. HOLDEN. *Iron Age,*
6 Vol. 132, Sept. 28, 1933, page 23. Throws some light on the question as to the relation of tempering colors to temperatures. Contends that the temperature regardless of color, is the only true indication of good tempering. While colors are guide to tempering certain conditions may tend to vary the colors regardless of temperature used such as time and atmosphere. Temper colors are only surface indications and not criteria of whole body of tool or die. Cites examples. VSP (5)

The Handling and Sharpening of Rock Drill Steel at the Wiluna Gold Mines Limited, Wiluna, W. A. H. H. CARROLL. *Proceedings Australasian Institute of Mining & Metallurgy,* No. 91, Sept. 1933, pages 397-409; discussion, pages 410-415. Steel, heated to 1850° F. is given a preliminary treatment in a sharpener and passed without reheating to a miller for finishing. After cooling it is tem-
7 pered. Magnetic indicators have eliminated soft bits. No benefit has resulted from use of alloy steels. AHE (5)

Heating or Annealing in Controlled Atmosphere. R. J. COWAN. *Metal Progress,* Vol. 25, Jan. 1934, pages 35-39, 52. Atmospheric requirements may be met by controlled flue gas or a muffle may be required to which is supplied the required atmosphere. For many operations industrial requirements as to surface free of oxide can be attained with controlled products of combustion. In forge furnaces with special burner equipment which introduces the gas and air in strata and combustion takes place as the layers diffuse together can be employed to heat billets to 2400° F. without scale. Strong decarburizing effects of H_2 and CO_2 can be prevented by proper amounts of hydrocarbon and CO. Nitriding and carburizing are processes carried out in closely controlled atmospheres to work a desired
8 change in the surface properties of the metal. The adverse effect of H_2 from the dissociated NH_3 in nitriding is avoided by a continuous process in which the NH_3 and work pass through a long muffle in the same direction. The steel takes up a surface case in the early stages of heating before the dissociation has proceeded far and this case protects against the action of H_2 in the latter stages where higher dissociation is met. Continuous carburizing is discussed as conducted in a series of reaction zones where the atmosphere is under definite control and identical results are obtainable from piece to piece. WLC (5)

Annealing (5a)

9

Electric Annealing Slashes Strip Steel Rolling Costs. P. N. RUGG. *Electrical World,* Vol. 113, Apr. 7, 1934, pages 500-503. Factors influencing the decision to install electric heat were: (1) with the electric furnace there is a minimum of dead-weight material to heat, so that a much shorter annealing cycle can be used, (2) shorter annealing cycle insures quicker deliveries, (3) charge is uniformly heated due to the heat distribution in the furnace chamber, (4) a better annealed and better-looking product, due to the close temperature control, (5) cleaner, cooler, and quieter working conditions in the annealing room, (6) lower over-all annealing costs. The equipment with each furnace consists of the bell-type furnace proper, 5 car bases, 5 protective hoods, furnace guides, car rails, automatic temperature controls and contactors. The artificial atmosphere is obtained by means
10 of a city gas purifier or an ammonia dissociator. Operating cycles are well controlled and quality products are obtained. The high C strip when annealed has: (1) a refined grain structure, (2) no decarburization at the surface, (3) bright surface appearance, (4) uniformly soft enough to pass the longitudinal folding test. The electric furnace installation saves $1.87 per ton in high C steel treating over the oil-fired equipment previously used and $2.66 for low C strip. CBJ (5a)

Normalizing Steel Castings. WIRT S. SCOTT. *Iron Age,* Vol. 132, Sept. 21, 1933, pages 20-23. Discusses the importance of knowing what happens in normalizing furnace in treatment of steel castings. Normalizing is done to increase tensile strength, increase elongation, relieve strains and remove hard spots, and thereby increase machineability of castings. Gives results of investigation on natural gas and electric furnace performanace and finds that best results and lower operating costs may be achieved with electrically heated unit. VSP (5a)

A Study of the Effect of Water Vapor on the Surface Decarburization of Steel by Hydrogen with Certain Developments in Gas Purification. C. R. AUSTIN. *Transactions American Society for Metals,* Vol. 22, Jan. 1934, pages 31-67. Data obtained from experimental work on effect of H_2 on the decarburization is reported where the purity of gas has been closely controlled. Pure gas has a definite but very limited decarburizing power at 800° C. on eutectoid steels. Increase in water content of gas, except at certain very low concentrations, increases greatly the decarburization by H_2. At concentration 10 mgs./water per cu. ft. of H_2 the decarburizing effect of gas is decreased from that obtaining with perfectly dry gas. Observations made have commercial significance in bright annealing of high C steel without decarburization. In discussion the critical water content connected with absence of decarburization is emphasized, effect of moisture in N_2 is discussed by W. E. Jominy and in Cl_2 by O. W. Ellis. WLC (5a)

Hardening, Quenching & Drawing (5b)

Hardening Cast Iron by Heat Treatment. J. E. HURST. *Iron Age,* Vol. 132, Oct. 26, 1933, pages 24-27, 67. See "Hardening Cast Iron," *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 278. VSP (5b)

Annealing Sheets. C. A. EDWARDS. *Heat Treating & Forging,* Vol. 20, Apr. 1934, pages 190-193, 203. From the William Menelaus Memorial Lecture before the South Wales Institute of Engineers. See "Influence of Rolling and Annealing Upon the Properties of Mild Steel Sheets," *Metals & Alloys,* Vol. 5, May 1934, page MA 225. MS (5b)

Some Problems of Quenching Steel Cylinders. HOWARD SCOTT. *Transactions American Society for Metals,* Vol. 22, Jan. 1934, pages 68-96; *Iron & Coal Trades Review,* Vol. 127, Nov. 17, 1933, page 763 (abstract). Constants required for solution of a quenching problem are diffusivity of the steel and quenching factor characteristic of the medium. Both have been evaluated for common steels and media. Variation in cooling rate at a significant temperature with the several variables obtaining the quenching of long cylinders were studied and compared with experimental results. Cooling rate distribution may be obtained by use of equations of transient temperature change under conditions not amenable to experimental attack. Cooling rate at center of long cylinders indicates the maximum size that can be fully hardened and can be estimated for common media. Cooling rates at center of cylinders quenched in water or oil vary little from maximum value over temperature range in which Ar_1 reaction in steel reaches a maximum. Maximum cooling rate is reached in quenching long cylinders in air or short ones in water or oil shortly after the beginning of quench and cooling thereafter can be expressed by simple relations. Increasing diameter decreases the advantage of water over oil in producing faster cooling at the center. Well agitated water offers the fastest physically attainable rate of cooling at center. Advantage of exceptional quenching power is to insure uniform shallow hardening in fine-grained steels. Appendix gives equations used. Ha + WLC (5b)

Quenching Steel in Hot Baths. H. L. DAASCH. *Metal Progress,* Vol. 24 Nov. 1933, pages 27-29. Physical properties are shown graphically on 3 steels, S.A.E. 1045 & 3130 and C tool steel of eutectoid composition heat treated by quench and draw and by "hot punch" treatment. Hot quenching bath is several hundred degrees cooler than draw temperature if comparable physicals are to be obtained in the single treatment. WLC (5b)

Microscopic Cracks in Hardened Steel, Their Effects and Elimination. E. S. DAVENPORT, E. L. ROFF & E. C. BAIN. *Transactions American Society for Metals,* Vol. 22, Apr. 1934, pages 289-310. Brittleness in fully hardened and tempered steel is due to real or potential microscopic quenching cracks which tempering even at very high temperatures may not eliminate. It is possible by transforming austenite at some higher temperature than that usual for martensitation, range 250°-900° F. By such treatment the formation of martensite is prevented and the cracks which accompany it. Hardness comparable to those obtained in hardened and drawn steel can be obtained in this way without the microscopic defects. Steel treated to 50 C-Rockwell by quenching in molten lead alloy at 580° F. for 15 min. and then into water showed the following properties compared to conventional quench and drawn steel. Analysis C 0.74%, Mn 0.37%, Si 0.145%, S 0.039%, P 0.044%.

	New Method (single treatment)	Conventional
Rockwell C	50.4	50.2
Ultimate Strength (lbs./in.²)	282,700	246,700
Yield Point (lbs./in.²)	151,300	121,700
Elongation (% in 6 in.)	1.9	0.3
Reduction in Area (%)	34.5	0.7
Impact (0.180 in round unnotched specimens, ft. lb.)	35.3	2.9

Conventional treatment was quench in oil at 70° F. from 1450° F. and temper 30 min. in lead at 600° F., micro-cracks were present in this material but absent in other specimens. Results average of 6 tests. Prevalence of micro-cracks increases with austenite grain size with severe loss of impact strength. Increased grain size adversely affects crack free steel to lesser extent. Superior toughness of many heat treated alloy steels is probably brought about by absence of microcracks with fine austenite grain, the necessary hardening capacity being provided by the alloying element which holds down grain size itself or this is effected by other elements or deoxidation method. Micro-cracks are believed to result from large dimensional changes within individual austenite grains accompanying the step-wise transformation to martensite. Intragranular stresses set up by gross volume changes may be much higher and are held responsible for micro-cracks. WLC (5b)

Evolution of Wear Resisting Rails. CECIL J. ALLEN. *Railway Engineer,* Vol. 55, Mar. 1934, pages 91-94. Traces the development of rails in which the head is of greater wear-resisting quality than the steel of the web and foot. Special reference is made to the martensitic rail of the Eisenwerkgesellschaft Maximilianshütte, Germany. This process depends on a sharp and rapid quenching (1 min. from 820° C. to below 200° C.) of the rail head in a stream of flowing water with a view of producing a martensitic structure on the running surface of the rails. Tempering then takes place to a certain extent by heat flowing from the interior of the head to the hardened upper surface so that the micro-structure approximates more closely to troostite. The period of immersion depends on the C content of the steel and on the desired degree of hardness and can be varied from a tensile strength of 120-140 kg./mm.² The Sandberg and the Neuves-Maisons processes produce a sorbitic structure by relatively gentle cooling. A diagram shows temperature-time curves on which the manufacture of pearlitic, sorbitic and martensitic rails is based. WH (5b)

Improved Hardening. *Automobile Engineer,* Vol. 24, May 1934, page 188. Temperature of heating and quenching of Cr-Ni steel gears is made dependent on the recalescent point of the material; a pyrometer regulates the furnace temperature and indicates proper time of removal after the recalescence point has been reached. Ha (5b)

Quenched Steel Hardness Related to Normality. HOWARD S. TAYLOR. *Metal Progress,* Vol. 25, Mar. 1934, pages 38-41. Data is presented on 8 steels showing that the hardness of SAE.1020 after a quench from 1600° F. is related to the McQuaid-Ehn reaction of the steel. Microstructures of carburized pieces of five steels show them to be "normal" and other three "abnormal." The quench from 1600° F. produces a hardness in excess of 350 Brinell, 367-476, in the five normal steels and hardness of 220 to 230 in the abnormal steels. WLC (5b)

Hardening Impression Dies. WILLIAM E. SNOW. *Machinery,* N. Y., Vol. 39, July 1933, pages 697-699; Aug. 1933, pages 790-792. Scleroscope hardness of impression dies should be from 84 to 89. In straight C steels 0.90% C is high enough if properly quenched. Alloy steels need less C. A Cr-V steel commercially known as Type K, C 0.08%, Cr 0.60 to 0.80%, V 0.15 to 0.20%, Mn 0.35 to 0.50%, Si 0.20 to 0.35%, and P and S 0.03% maximum gives satisfactory results. Hardens to a depth of from ¼" to ⅜", scleroscope 85 to 90. Gives specific directions for handling, packing and heating the die. Heat should be applied in three progressive steps, 1200°, 1300° and 1400°. Quenched in running water. Describes quenching tank. Tempering may be done in either a furnace or an oil bath. Drawing temperatures range from 350° to 480° F. Gives numerous suggestions for correct hardening. RHP (5b)

Gear Hardening with Oxy-Acetylene. FRANCIS W. ROWE. *Metal Progress,* Vol. 25, Feb. 1934, pages 39-40. A machine and technique for surface hardening of large gear teeth by acetylene torch is described. Macrograph shows the depth and location of hardness obtained. Hardness of 450 to 700 Brinell is said to be obtained and good service results. WLC (5b)

The Treatment of High-Speed Steel. FRANCIS W. ROWE. *Machinery,* London, Vol. 43, Dec. 21, 1933, pages 347-352. Discussion of the limitations of super high-speed steel. The composition of the steel mainly referred to in the article is given as follows: 0.68-0.80% C, 0.30% max. Si, 0.030% max. S, 0.030% max. P, 0.20-0.35% Mn, 17.6-18.8% W, 3.75-4.75% Cr, 1.0-1.45% V and the influences of the main alloying elements are illustrated. Dealing with raw materials, manufacturing technique, and hardening, controlled atmosphere electric furnaces and forced air circulation furnaces for secondary treatment are touched upon. In all the treatments which are discussed, time is just as important as temperature. Microphotographs illustrate the effect of heat-treatment time on microstructure. After dealing with quenching technique and media the effect and importance iof secondary hardening are stressed. Diagrams illustrate the influence of varying temperatures and time of secondary treatment on the hardness of high-speed steel. In conclusion data on costs of heat treatment in electric furnaces are furnished. Kz (5b)

Steel is Embrittled if Quenched in Critical Range. JAMES J. CURRAN. *Metal Progress,* Vol. 25, Feb. 1934, pages 27-33. During an attempt to salvage certain carburized parts for which 3½% Ni steel of 0.35% C. had been used it was noted that quenching in the vicinity of Ac_1 resulted in a very brittle condition. Quenching at lower temperatures showed great toughness and at higher temperatures a portion of the toughness was recovered. All specimens were small, about ¼" diameter and were quenched from a rising temperature, without soaking. Soaking made brittleness less noticeable. More recent tests are reported on Cr-Ni S.A.E. 3145; Ni, 2330; Cr-V, 6150; Cr-Mo, 4140; C, 1035; and Mn free-cutting steel of C 0.35% and Mn 1.50%. Specimens were 3-4 in. long from cold drawn rounds or hexagons ¼-¾". Heated in small electric muffle with automatic control and quenched in oil from temperatures every 20° F. from 1260°-1520° F. The heating was carried out with six specimens on a tray and thermocouple close to work, automatic control set for a temperature 60° F. below that at which quenching was to be made and soaked out at that temperature and then control set for quench and tray removed and specimens quenched as soon as the control shut off the current on arrival at temperature. Curves show the bend test results and hardness against temperature. Embrittlement is most pronounced in cases of 3½% Ni and Mn steels at temperatures of 1290° and 1330° F. respectively and both show recovery of former ductility at 1370° and 1400° respectively. The other steels show the sharp drop in ductility but little or no recovery. These facts may explain cracking or brittleness encountered with low quenching temperatures. WLC (5b)

Aging (5c)

Hardening of Aluminum-Copper Alloys (Die Aushärtung von Kupfer-Aluminumlegierungen). H. BOHNER. *Zeitschrift für Metallkunde,* Vol. 25, Dec. 1933, pages 299-305. Fifteen alloys, containing Cu between 5.93 and 6.45%, with additions of less than one per cent of Mn, Ni, Ti, Fe, and V, singly and in combination made from commercial Al containing 99.6-99.8% Al, the residue Fe & Si, were prepared in large ingots (62 cm. long, 22 cm. diameter) and forged and finally drawn to 3 mm. wire. This made available alloys much more homogeneous, yielding much more uniform testing data, than any prepared on a laboratory scale. Heat treatments were performed by heating 2 hrs. in a salt bath at 520-540°, quenching in water, and aging in oil at 120-140°. Measurements were made of yield point, tensile strength, bending values, in order to determine the effect of variations in heat-treatment and alloy content. The data show, contrary to previous opinion, that binary Al-Cu alloys containing 6% Cu can be made, upon proper heat-treatment, to show mechanical properties superior to alloys with less Cu. Retention at room temperature for several days after quenching and before drawing favors the development of high values for mechanical properties; similarly a mixed thermal treatment, aging first at a low then at a high temperature, is favorable. Mn and Ti raise the strength of the 6% Cu alloy, and also the resistance to attack by chemicals. Ni decreases the mechanical properties, not only for binary Al-Cu alloys, but also the ternary alloys Al-Cu-Mn, Al-Cu-Ti, and Al-Cu-V. V has no influence upon the mechanical properties for much-worked alloys, but on less-worked alloys the properties are lowered by V. Preliminary cold work gives higher yield points with little effect on strength and elongation. Superior corrosion resistance and bending qualities are obtained by plating with Al or Al alloys; in such products strength values may be produced equal to those of the unplated alloys. Alloys of Al-Cu-Mn, Al-Cu-Ti and Al-Cu-Mn-Ti with Cu approximately 6% will develop the mechanical properties of very special types of duralumin. RFM (5c)

Notes on the Aging of Metals and Alloys. ALBERT SAUVEUR. *Transactions American Society for Metals,* Vol. 22, Feb. 1934, pages 97-119. C is held to be chiefly responsible for age hardening in Fe-C alloys, N_2 in large quantities may play a part but the part of O_2 is doubtful. Hardening may take place in solid solution made supersaturated by quenching or in cold worked material by aging. Brinell impressions are used to cold deform and Rockwell readings taken in this impression to follow the hardening effect. In Fe-C alloys a maximum of ferrite is necessary for aging effects which will be entirely prevented or greatly minimized by martensitation. Discussion. WLC (5c)

Malleableizing (5d)

Present Status of Malleable Iron (Heutiger Stand des Tempergusses). K. ROESCH. *Stahl und Eisen,* Vol. 54, Mar. 29, 1934, pages 305-310. A survey of the latest methods of melting and annealing malleable iron, giving compositions, properties and possible defects. The strength and ductility of malleable iron has recently been increased, the annealing time decreased. SE (5d)

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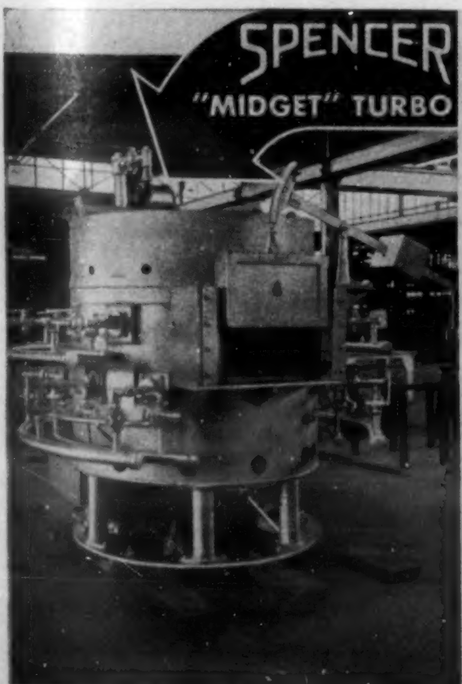

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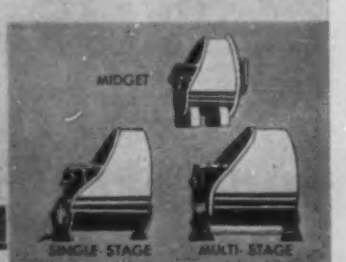

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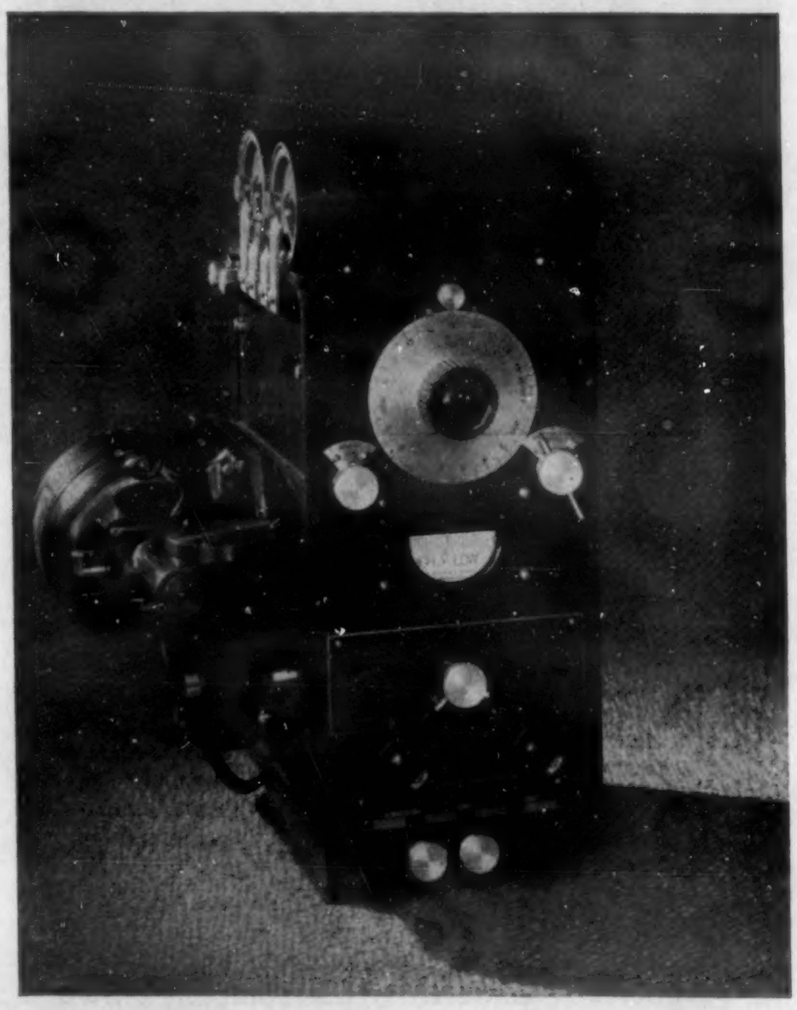

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FURNACES, REFRACTORIES & FUELS (6)

M. H. MAWHINNEY, SECTION EDITOR

Powdered Coal Rotary Melting Furnace (Le Four Rotatif de Fusion Chauffe au Charbon Pulverise) J. GOFFART & F. BOUSSARD. *La Fonderie Belge,* Vol. 3, June-July 1933, pages 80-86. Paper read at the "Journée du Charbon Pulvérisé" (Powdered Coal Day). To show advantages of rotary furnace over cupola, the author explains the shortcomings of cupola for the new requirements of modern industry: (1) Cupola has difficulty melting high strength cast Fe which, owing to its low C, Si and P contents, possesses a high melting point and a poor fluidity. Moreover, with cupola, melting losses are as high as 4-5%. (2) Only 40-45% of heat furnished by coke combustion are actually used for melting. (3) Manufacture of coke requires special coals therefore price of coke is high. (4) Technically speaking, cupola is also imperfect: (a) it is difficult to vary the composition from one charge to another and this is frequently necessary, (b) when alloy additions are to be made in the liquid metal, i.e. in the ladle, there is a cooling of the metal, (c) it is difficult to melt a small quantity of cast Fe in the cupola. Advantages of rotary furnace using pulverized coal are as follows: (1) it is possible to obtain liquid cast Fe at temperatures up to 1650° C. (2) Any given quantity of cast Fe with accurate chemical composition can be melted easily. (3) Rotary furnace is practical and economical. (4) Alloy additions are made without difficulty and composition of metal can be changed or corrected just prior to tapping. (5) It is possible to maintain so long as needed a liquid bath at high temperature (useful particularly for superheating of metal and removing gases and slags from the bath). In the latter section of paper, the authors deal with construction details of the furnace; barrel, burner, coal crushing and distributing devices, heat recuperators, chimney, charging devices. FR (6)

Use of Powdered Coal in Production of Cast Iron (De l'Emploi du Charbon Pulverise dans l'Obtention des Fontes). P. FRION. *La Fonderie Belge,* Vol. 3, June-July 1933, pages 86-93. Paper read at the "Journée du Charbon Pulvérisé" (Powdered Coal Day). The author explains development brought about by those furnaces in the foundry practice for the melting of "quality cast Fe." Originally quality cast Fe had a pure pearlitic matrix and graphite and it was possible to melt it in the cupola but, actually, together with this structure, low carbon and high silicon contents are aimed at in high strength cast Fe and it is difficult to melt such cast Fe in the cupola. Furthermore in alloy cast Fe the problem of alloy additions requires hot metal. In cupola, the carburization depends upon the time of contact of metal with coke. For producing low carbon cast Fe, melting must be rapid and cupola has to be handled by skilled and experienced men. On the other hand, low carbon cast Fe melted in the cupola is not very fluid and contains gases so that it is difficult to run thin castings with it. For these reasons, a more flexible furnace is needed in which control of composition and temperature can be carried out. Electric furnace answers these requirements but melting is too costly in this furnace the installment of which is also very expensive, so that this furnace is only suitable for very special types of high quality cast Fe. Melting high strength cast Fe is also expensive in air and open hearth furnaces which have high installation costs and can only be applied to large quantities of metal. Then the author shows that the rotary furnace heated with pulverized coal is actually the more suitable furnace for melting all the new kinds of quality cast Fe required by modern industry. Advantages of the melting furnaces are: (1) flexibility, (2) high melting and superheating temperatures, (3) long life of refractories, (4) homogeneity of cast Fe obtained. (5) freedom from oxides and gases in the metal melted, (6) possibility of using cheap materials. FR (6)

Appraisal of Industrial Gas Fuels. A. E. BLAKE. *Iron Age,* Vol. 131, May 25, 1933, pages 816-818, adv. sec. page 14; June 1, 1933, pages 854-855. Purpose is to furnish supplementary information to assist in making more accurate cost comparisons, a number of gases are dealt with. Emphasizes the present practice of attaining either perfect combustion or some constant, predetermined amount of O_2 in furnace atmospheres. Includes a table giving data on the changes of furnace atmosphere which may be expected when a substitution of fuel is made and permits some prediction of the effect of such changes. As an aid in predicting effect of a change in composition a graph is included. VSP (6)

Experience with the K.-S. Ellipsoid Rotating Furnace (Betriebserfahrungen mit dem K.-S.-Ellipsoid-Drehofen). F. HÖHNE. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 54, Oct. 15, 1933, pages 431-432, Oct. 29, 1933, pages 453-455, Nov. 12, 1933, pages 475-474, Nov. 26, 1933, pages 493-494. Author gives a detailed account of his experiences with the K.-S.-rotating melting furnace. He first deals with advantages and disadvantages of other melting furnaces, as crucible furnaces, electric furnaces, oil fired reverberatory furnaces. The metallurgical disadvantages of the latter type are especially pointed out. These difficulties are due to gases formed upon melting in deoxidizing atmosphere. Oil fired furnaces should always be operated with slightly oxidizing atmosphere. Tests show that tensile strength and elongation of metals melted in neutral or slightly oxidizing atmosphere are by about 20% higher than in melting in neutral or slightly reducing atmosphere. Density of material is also better in this case. The discussion of best atmospheric condition in oil fired furnaces is followed by consideration of the various possibilities of leading the flames in these furnaces; (1) direct firing, (2) heating by radiation (3) indirect heating. The latter method is applied in the K-S furnace in that the flames are directed upon the furnace walls that radiate the heat upon the material to be melted. Construction and operation of a K-S furnace of a capacity of 500 kg/heat is considered at length in the 3rd instalment. For bronzes the melting time amounts to about 10 minutes/100 kg. Melting time for brasses is somewhat lower; for metals and alloys of higher melting point, as Ni and special bronzes, higher. Superheating in this furnace may have detrimental effects. Superheating times that may hardly show detrimental effects in other furnaces may lead to total oxidation in the K-S furnace. The K-S furnace offers the advantage that charges consisting of scrap to 100% can be melted. Furnace lining is particularly referred to. 125-130 tons can be melted per furnace lining. Finally, efficiency of operation of the furnace is compared with crucible furnaces. GN (6)

The Electric Filter as Important Operating Device in European Industry (Das Elektrofilter als wichtige Betriebseinrichtung in der europäischen Industrie). R. HEINRICH. *Elektrotechnische Zeitschrift,* Vol. 55, Apr. 26, 1934, pages 413-417. The principles and construction of electric dust precipitation are briefly described, their application in metallurgical, chemical and other industries and for cleaning waste gases, and the great economy and improvement in utilization of materials by recovery in dust form explained. The value of dust at present precipitated in 2600 filters is estimated at 60 million RM and includes metal, cement, coal dust and dusts from gases. Ha (6)

Some Factors Leading to Greater Production from a Steel Furnace. ARTHUR ROBINSON. *Engineering,* Vol. 136, Sept. 22, 1933, pages 345-346; **Getting Increased Production from a Steel Furnace.** *Iron Age,* Vol. 132, Nov. 2, 1933, pages 28-29. From a paper read before the Iron & Steel Institute, Sept. 13, 1933. See *Metals & Alloys,* Vol. 5, May 1934, page MA 188. LFM + VSP (6)

Eliminating Draft Trouble in Metallurgical Works. E. R. THEWS. *Metal Industry,* London, Vol. 44, Mar. 23, 1934, pages 317-320. Attention is called to several points which might cause defective draft by inadvertence or accumulation of dust. Ha (6)

The Calculation of Open Hearth Furnace Regenerators. HERBERT SOUTHERN. *Journal Institute of Fuel,* Vol. 6, Aug. 1933, pages 369-380; discussion pages 380-387. The work of the German Heat Economy Bureau and others on the design and operation of regenerators is summarized in a mathematical form. AHE (6)

The "Reversible" Thermal Expansion of a Silica Brick. J. A. SUGDEN. *Jour-
nal Society of Glass Technology*, Vol. 17, Dec. 1933, pages 378-383. Thermal
expansion of a silica brick over the temperature cycle 20°-700°-20° C. was found
to be not strictly reversible. A small permanent expansion remained, the extent of
which decreased rapidly with each repetition of the cycle. The mechanism of expan-
sion of an agglomerate is discussed in this connection (a wall, for instance). 1
Ha (6)

Refractory Concrete. R. T. GILES. *Metals & Alloys*, Vol. 5, Feb. 1934,
pages 28-30. Portland Cement is not satisfactory for use in a refractory concrete
on account of the nature of the compound formed. A high alumina cement consist-
ing principally of calcium aluminate is more satisfactory. The refractoriness of such
concrete will depend upon the refractory material, fire clay, magnesite or chrome
ore, which is used with the high alumina cement. The refractory material should
contain considerable more fines than usual in ordinary concrete, 15% should pass 100
mesh. Mix dry to uniform color and add cold water to make plastic. If a great deal
of ramming is required in placing it is probable that insufficient fines or water or
both have been used. In placing, planes of weakness between batches should be
watched and guarded against. 24 hours will attain the full cold strength. Refrac- 2
tory concrete is being used increasingly for linings and patches in all kinds of
furnaces. WLC (6)

Lump Peat as a Fuel for Blast Furnaces. B. M. SUSLOV. *Iron Age*, Vol.
132, Nov. 16, 1933, pages 17, 47. Discusses the use of peat as fuel in blast fur-
naces in Russia. Recent accomplishment is the use of peat in combination with
calcined pyrites. As a result of tests furnaces particularly adapted to this fuel are
to be constructed. VSP (6)

Car-Bottom Annealing Furnace Installations. H. M. HEYN. *Iron Age*, Vol.
132, Aug. 24, 1933, pages 20-21, 52. Describes a gas fired car bottom furnace.
It is used for annealing steel castings and stress relieving in welded work, such as
pressure vessels. Inside dimension of furnace is 18 x 80 ft. Sixty-two two stage 3
high pressure burners are used to fire furnace. Emphasizes the flexibility of this
class of furnaces. Includes data on the performance of recent cartype annealing
furnaces. VSP (6)

**Electric Furnace in the Iron and Steel Industry (Le Four Electrique en
Sidérurgie).** S. E. HEULAND. *La Technique Moderne*, Vol. 26, Jan. 15,
1934, pages 56-63. Reasons which explain great development noted in France in
the use of electric furnaces are: (1) Improvements in manufacture of furnaces and
apparatus. (2) High quality of product obtained, this quality more easily reached
than with common processes. (3) Arrangements are made between manufacturers and
users of electric current. Last section of the article deals with selection of
apparatus. FR (6)

4

**Electric Furnace with Automatic Temperature Regulation (Ein elektrischer Ofen
mit selbsttätiger Temperaturregelung).** J. HAK. *Elektrotechnische Zeitschrift*,
Vol. 55, Apr. 12, 1934, pages 367-369. The furnace has a core of magnetic mate-
rial of a special magnetization characteristic. The higher the temperature the less
magnetic flux goes through the core, and the current becomes smaller. This is used
for automatic temperature regulation; the theory is derived. Ha (6)

Olivine Reveals Properties for Production of Special Refractories. R. A. HEINDL
& W. L. PENDERGAST. *Brick & Clay Record*, Vol. 84, Apr. 1934, pages 129-
130. New raw material from N.C. was formed into brick and burned at 1425°C.
Chemical analyses showed SiO_2 from 40 to 45% approx., MgO 40 to 49%, ferrous
oxide 7 to 15% and lesser amounts of Al_2O_3, Ca and Ti. The rate of thermal ex-
pansion was fairly regular up to 900°C. The total expansion from 20° to 900°C. 5
ranged from 0.942 to 1.082% and is somewhat lower than magnesite. The true
sp. gr. range from 3.206 to 3.420 for the raw material and between 3.294 and
3.434 for the material heated at 1400°C. The P.C.E. (softening point) ranged
from 30 to above 35, except the material high in CaO which varied from 11 to 16.
Petrographic examination shows the material to be essentially olivine. The N.C.
olivines are more refractory than those of other sources. The brick proved satisfac-
tory in the physical tests applied. CBJ (6)

**Highly Refractory Silicon Carbide Bricks for Boiler and Industrial Furnaces
(Hochfeuerfeste Siliziumkarbid-Steine in Dampfkesselfeuerungen und Industrieöfen).**
CURT RÜHL. *Elektrizitätswirtschaft*, Vol. 33, Jan. 15, 1934, page 18. The
remarkable resistance of SiC against scorification is stressed. By selection of proper 6
binding materials, refractory bricks which contain 85% SiC can be made. However,
these bricks are subject to attack by oxidizing gases. Favorable results with SiC
bricks are reported with reference to enameling furnaces whose heating-up times
could be halved. Two tables give data on compressive strengths, melting points in
°C. and Seger cones in comparison with the most important refractory materials on
the market. WH (6)

Physical Properties of Ten Brands of Insulating Refractories. W. C. RUECKEL.
Brick & Clay Record, Vol. 84, Mar. 1934, pages 89-90. A compilation of bulk
density, porosity, transverse and crushing strength, and permeability of 10 different
refractories and their chemical characteristics are given. Ha (6)

The 3-Phase Electric Arc Furnace. SAM. ARNOLD. *Blast Furnace & Steel
Plant*, Vol. 22, Apr. 1934, pages 214-218. See *Metals & Alloys*, Vol. 5, Mar. 7
1934, page MA 110. MS (6)

"Fireless" Salt Baths Heated by Resistance. A. E. BELLIS. *Metal Progress*,
Vol. 25, Jan. 1934, pages 25-28. One of the objections to use of salt or lead
baths for heat treating operations especially at higher temperatures required for
some alloys steels and high speed steel is the rapid deterioration of the salt con-
tainers under the flame action. Development of resistance heating is described which
first used the container as one electrode but is now eliminating the pot from the
electrical circuit with entire satisfaction. Pots as long as 28 ft. with width and
depth of 3 ft. are being successfully operated by this type of resistance heating with
electrodes immersed in the salt. WLC (6)

Comparison of Solid, Liquid and Gaseous Fuels. J. C. BARCLAY, *Heat Treating* 8
& Forging, Vol. 20, May 1934, pages 247-248. Brief discussion of merits of
various fuels for industrial heating. MS (6)

Plymouth Uses Induction Type Ovens to Bake Enamel on Steel Parts. E. L.
BAILEY. *Iron Age*, Vol. 132, Sept. 14, 1933, pages 23, 70. Describes method
used at the plant of Plymouth Motor Corp'n., Detroit. Using induction type ovens
the usual application of heat from without is reversed. Heat from the sheet passing
outward through enamel coating frees the surface from holes and wrinkles and re-
duces enameling time. VSP (6)

Multizone Gas Washer Serves as Scrubber and Drier. *Steel*, Vol. 94, Apr. 2, 1934,
page 44. Describes 3-stage washer for cleaning blast-furnace gas. In the first
zone, gas enters tangentially near the bottom. Heavier dust particles are 9
thrown centrifugally against the shell where they are entrapped in a H_2O film
thereon. In the 2nd zone, the gas passes through wetted wooden hurdles,
the hurdle slots being staggered vertically, with free spaces across the washer
horizontally between successive courses of hurdles. In the 3rd zone, gas enters
an annular drum, central portion of which is divided by a metal plate. Within
the drum and practically parallel to its vertical walls, are a number of vertical rub-
ber vanes, spaced so as to form narrow concentric passages for the gas. Curvature of
these vanes is on an ever-increasing radius. This zone acts as a cleaner and drier.
MS (6)

**Electric Furnaces at Mathis Automobile Works (Les fours électriques aux usines
d'automobiles Mathis).** *Journal du Four Electrique*, Vol. 43, Apr. 1934, pages
134-137. The company applies electrical heating wherever possible. It has arc 10
furnaces for making high test cast iron, and electric furnaces for heat treatment,
cyaniding and enamelling. Russ vertical core drying oven 16 meters by 2 meters
square practically eliminates drying losses. Cores travel in it on supports carried by
an endless chain. The drying cycle takes approximately one hour. With very heavy
cores the cycle is repeated. JDG (6)

Chief Methods of Control of Mechanical Qualities of Metallurgical Coke: Blast-Furnace and Foundry Coke (Principales Methodes de Contrôle des Qualités Mécaniques du Coke Métallurgique: Haut-Fourneau et Fonderie). M. GEVERS. *La Fonderie Belge*, Vol. 3, Oct. 1933, pages 151-156. Tests described are the following: (1) Drop or shatter test, originated in America and largely used in England. (2) Barrel test, used in Germany and France. (3) Compression test, used by Hoesch mills in Dortmund. (4) Wear test (against an abrasive wheel), used in Germany. (5) Crushing test similar to that used for engineering materials. Conclusions of the article are: Shatter and barrel tests are the most largely used, both methods leading to correct studies of coke. Remarks of various experimentators agree that the coke remaining on a screen of given size does not characterize quality of coke, it is necessary to consider the condition of coke portion which has passed through the screen. Other tests are used only in special cases. FR (6)

Graphite. Various Industrial Applications of Natural and Artificial Graphites (Le Graphite. Emplois Industriels Divers des Graphites Naturels et Artificiels). H. RABATÉ. *La Revue Industrielle*, Vol. 63, Apr. 1933, pages 193-198. This article is the 5th of a series which up to present had little of metallurgical interest. In present section, uses of graphite in crucibles and refractories are reviewed: Crucible mixtures are composed of 1/3 clay and 2/3 graphite. Graphite from Passau, Ceylon or Madagascar is used. Graphite in spangles, not too thin but without fines, with 85-95% C. giving minimum fusible ashes and with minimum impurities must be preferred. Applications for above refractory mixtures are the following: nozzle stoppers, steel pouring ladles, protection pyrometer envelopes, baking boxes, refractory bricks, cements for refractory retorts, etc. Use of graphite as mold blacking in foundry is dealt with, uses in metallurgy (1) recarburization of cast Fe and steels, (2) addition of P in bronzes as well as miscellaneous uses are reviewed. FR (6)

Effect of Supplementary Heating on the Rate of Heating of Ingots and on the Economy of Pusher Type Furnace Operation (Der Einfluss der Zusatzbeheizung auf die Erwärmungsbedingungen der Blöcke und die Wirtschaftlichkeit des Stossofenbetriebes). O. GÜNTER. *Stahl und Eisen*, Vol. 54, Apr. 5, 1934, pages 344-348. Supplementary side burners are only justified when the furnace is heavily loaded, but it is more economical to overload a furnace in this way than to use two normally operated furnaces. SE (6)

The Thermal Expansion of Silica Brick (Die Wärmeausdehnung von Silikasteinen). F. FROMM. *Archiv für das Eisenhüttenwesen*, Vol. 7, Jan. 1934, pages 381-384. Details are given of the apparatus in which the thermal expansion of 5 silica brick of the same composition but varying in specific gravity from 2.38 to 2.44 was determined at temperatures of 1600° and 1400° C. The thermal expansion increased with the specific gravity. After heating to 1600° C. the samples became more porous and the specific gravity fell to 2.32. SE (6)

Electric Furnace Refractories in the Brass Foundry. H. M. ST. JOHN. *Metals & Alloys*, Vol. 4, Dec. 1933, pages 183-191. The Committee on Non-Ferrous survey reports the results of its canvas of 165 users of electric furnaces for melting brass as to their refractory practices. 84 replies, 63 active reports were received representing 167 furnaces of daily melting capacity of 780,000 lb. Furnaces distributed as follows: Detroit Rocking 129, Ajax-Wyatt Induction 26, Repel-arc 9, and Baily Resistance 3. Questionnaire addressed to all brass melting foundries using electric furnaces contained 17 questions regarding capacities, alloy compositions, pouring temperatures, lining and patching materials, their method of application and life, and refractory cost. The responses are tabulated complete. Very wide variations in refractory cost are reported. These are discussed and tabulated with reference to size, tonnage per lining, and cost per ton. WLC (6)

Construction and Operation of Open Hearth Furnace Fired with Cold Coke-Oven Gas (Bau und Betrieb von mit kaltem Koksofengas beheizten Siemens-Martin-Oefen). O. SCHWEITZER. *Stahl und Eisen*, Vol. 54, Jan. 4, 1934, pages 1-11; Jan. 11, pages 29-36. A very detailed account with 42 illustrations and drawings of 30 and 100-ton stationary open-hearth and 100-ton tilting open-hearth furnaces fired with cold coke-oven gas. Under favorable conditions the daily output with the 30-ton furnaces is 180 tons and with the 100-ton furnaces 400 tons. Good gas efficiency is obtained. Further improvements in design are suggested. SE (6)

Characteristics of Some Fuel Fired Furnace Control Systems. R. A. SMART. *Metals & Alloys*, Vol. 4, Oct. 1933, pages 153-158. Lag is one of the difficulties in furnace temperature control and is divided into three parts, (1) the lag between the temperature surrounding the thermocouple and its appearance on the indicating or recording instrument, (2) the lag between change of fuel valves and actual change in the surroundings of the thermocouple and (3) a passage of time necessary to indicate the extent and permanency of any change in temperature before the correction can be properly made. A furnace that cannot be controlled manually cannot be controlled automatically and only some manually controllable furnaces can be automatically controlled. The effect of the lag factors upon the type of curve which can be drawn by manual control is discussed. Multiple positions make the control more adaptable to varying conditions. The effect upon atmospheric conditions in the furnace due to frequent changes in fuel supply may become serious especially where "stack" effects are inherent in the furnace installation. Air and fuel valves that will have a constant port ratio at all setting and suitable control of the flow of both to and from the control valve are essential for maintaining uniformity of atmosphere with temperature control. The efficiency of the controller greatly affectes the fuel economy. Curves illustrate the various types of control systems. WLC (6)

Determining the Most Economical Checker Work in Regenerator Stones (Berechnung des wirtschaftlichsten Gitters eines speichernden Wärmeaustaucher). K. RUMMEL & G. SCHEFELS. *Archiv für das Eisenhüttenwesen*, Vol. 7, Apr. 1934, pages 547-549. Calculations based on given operating conditions of a blast furnace stove are used for determining the most economical type of checker work in respect to the necessary heating surface, height of checkers, canal length, strength of the brick, and relative roughness of the surface. These factors may affect the cost of stove operation as much as 35%. SE (6)

The Reactivity of Coke. JOHN ROBERTS. *Colliery Engineering*, Vol. 10, July 1933, pages 220-222, 230. Study of raw coals to appreciate the differences in character of cokes. It is essential that a furnace coke should have good combustible properties, that is, it should have good reactive properties with air in the melting zone of the furnace, but it should not be readily reacted upon by carbon dioxide in the reducing zone. Since a superior furnace coke cannot be described as one that possesses high reactivity (melting zone) and low reactivity (reducing zone) the author says it is essential to test the resistance of the coke to the solvent action of CO_2 and the property thus determined should be termed the "CO_2 resistivity," or simply "resistivity." Soft coke is acted upon by CO_2 at a temperature of about 427° C., while good hard coke resisted the action until a temperature of 815° C. was reached. The efficiency of heat utilization in a blast furnace depends upon the concentration of heat and this is best produced by a hard fuel. Discussion of the cause of the varying degree of reactivity and the influence of coking temperature. Dealing with properties of foundry coke, experiments of the Northern Coke Research Committee with metallurgical cokes are discussed. Kz (6)

Electric Furnaces at Trubia (Spain) Gun Factory (Les fours électriques à la fabrique de canons de Trubia (Espagne).) *Journal du Four Electrique.* Vol. 43, Apr. 1934, pages 137-138. A brief description of the plant having 2 open hearth furnaces of 40 and 25 tons, 2 electric Demag-Fiat of 8 tons and one Lectromelt of 0.5 ton and the necessary equipment. JDG (6)

Rebuilt Furnace Saves Gas. *Heat Treating & Forging,* Vol. 20, Apr. 1934, pages 195-196. At the Youngstown Sheet & Tube Co., Youngstown, O., an old coal-fired sheet furnace was redesigned and transformed into a gas-fired, Costello type pair furnace. An average of 1007 cu. ft. of 1100-B.t.u. natural-gas is burned to heat 1 net ton of steel. Other furnaces adjoining this one require 1848 cu. ft. of gas per ton of steel. MS (6)

New Lines in Utilization of Powdered Coal Firing for Foundry Furnaces (Neue Wege für die Anwendung der Kohlenstaubfeuerung bei Giessereiöfen). *Feuerungstechnik,* Vol. 21, Oct. 15, 1933, page 143. Powdered coal firing equipment is discussed and illustrated which utilizes the waste from rough coal cleaning (maximum size of 4 mm.) and thus eliminates the former considerable grinding costs involved in powdered coal firing. In lieu of the former burner, the fuel drops from a simple cylindrical nozzle in the furnace arch in to a rotating combustion air current. Eventually unburnt coal drops on a grate. Analysis of ash taken from the latter shows 0.03-0.11% C. A wider utilization of reverberatory furnaces for cast Fe is discussed. EF (6)

Arc Furnaces (Lichtbogenöfen). *Elektrizitätswirtschaft,* Vol. 33, Jan. 15, 1934, pages 16-17. In recent arc furnaces the voltages have been raised from 130 volts to 240 volts and the specific furnace loads from 150 kw./ton to 450 kw./ton. The melting-in periods could be halved thus cutting down the heat losses and energy consumption which is nowadays 400-500 kw.hr./ton. The structural improvements accomplished on recent arc furnaces are listed. A smaller type designed for small shops, foundries, repair shops is described and illustrated. WH (6)

Steel Smelting and Refining. *Electrical Review,* Vol. 114, Apr. 20, 1934, pages 550, 557. Describes 2-ton and 5-ton high-frequency electric furnaces recently completed at Stocksbridge, Eng. Pays chief attntion to the electrical features. Believed to be the largest of its kind in Eng. Furnaces are arranged for acid or basic lining and tilt in both directions. Research laboratory has 3 small electric furnaces for heat treating. See also editorial on page 547. MS (6)

Cupola Linings. J. C. Green. *Refractory Journal,* Vol. 10, Jan. 1934, pages 20-22. The minimum temperature in the melting zone, in a cupola is in the neighborhood of 1700°C. Beside brick lining, the rammed lining is more common. The material used for ramming is siliceous in character, and the refractoriness is seldom, if ever, higher than 1670°C. Excess of limestone used in most cupolas causes rapid destruction of the lining in the melting zone. GTM (6)

On the Behavior of Refractory Bricks against Slag Attack (Beitrag zum Verhalten on Schamottesteinen gegen Schlackenangriffe). Fritz Fromm. *Berichte der deutschen keramischen Gesellschaft,* Vol. 15, Feb. 1934, pages 49-65. 50 refractory bricks (corundum bricks, sillimanite bricks, common fire clay bricks and quartz fire clay bricks) were used in these investigations studying the attack of ashes on the slagging in relation to their porosity and Al_2O_3 content. In these slag attack tests at 1400° C no considerable difference of behavior of the various bricks was found. Only at higher temperatures and with longer duration of slag attack large differences were apparent. No relation could be found between Al_2O_3 content and slag attack. At 1400°C slag attack increases but to a slight extent with increasing porosity, however, at 1450°C there exists a more pronounced dependence of slag attack on porosity. GN (6)

JOINING (7)

Joining Methods for Instrument Members (Verbindung von Werkstücken zu Bauteilen feinmechanischer Geräte). K. H Sieker. *Zeitschrift für Fernmeldetechnik, Werk- & Gerätebau,* Vol. 14, Sept. 16, 1933, pages 134-138. Fully discusses the various joining methods utilized in connecting members of delicate designs such as instruments by screwing, clamping, welding, brazing, soldering, riveting and folding. EF (7)

Soldering & Brazing (7a)

C. H. CHATFIELD, SECTION EDITOR

Soft Solders and Soldering Fluxes. E. E. Halls. *Sheet Metal Industries,* Vol. 8, Mar. 1934, pages 175-176, 186; Apr. 1934, pages 231-232, 244; May 1934, pages 299-300. Discusses Pb-Sn diagram and indicates lines along which solders should be selected. Recommends four solders to cover most work for any operating conditions.

			Antimony %		
	Min.	Max.	Min.	Max.	Lead %
A	64	66	..	1.0	Remainder
B	49	51	2.5	3.0	Remainder
C	39	41	2.0	2.4	Remainder
D	29	31	1.0	1.7	Remainder

Outlines function of soldering fluxes and discusses characteristic properties of the three main groups of fluxes, i.e. chloride, resin, and special-purpose fluxes. Flux-cored solders are dealt with and washing methods for each of the 3 flux groups are set forth. AWM (7a)

Solder—Effect of Impurities on Its Appearance and Microstructure. Clifford L. Barber. *Industrial & Engineering Chemistry,* Vol. 26, June 1934, pages 685-687. It was found that the frostiness on bar solder is largely influenced by the relative thermal capacities of the solder mold and a given poured bar. Satisfactory results may be obtained by using a mold whose total mass is about six to eight times that of the bar. Sb, Bi, Cu, Ag, Ni, and As have no part in the frostiness. Zn (0.01%), and Al and Cd (0.01%) produce a noticeable roughness and frostiness and a distinct change in microstructure. The round, raised, cooling spots usually attributed to Sb, are really caused by As or Ni which are about 100 times more active in producing this curious effect. MEH (7a)

Fluxes for Hard Soldering and Welding of Aluminum and Its Alloys (Flussmittel zum Hartlöten und Schweissen von Aluminium und seinen Legierungen) *Metallwaren Industrie & Galvanotechnik,* Vol. 31, Sept. 1, 1933, page 309. Fluxes for hard soldering and welding of Al are mixtures containing fluorides and chlorides of Na, K, Li, Mg, Ca, Zn and Ba. EF (7a)

Effect of Cadmium on Properties of Silver Solders (Einfluss des Kadmiums auf die Eigenschaften von Silberloten). *Die Metallbörse,* Vol. 24, Jan. 13, 1934, page 51. Replacng part of the Zn by Cd in Ag solders improves fluidity and physical properties. Replacing Cu by Cd in Ag solder lowers the melting point and casting temperature. The following data on the melting and flow points show the effect of Cd:

Ag	Cu	Zn	Cd	Melting point °C.	Flow point °C.
65	20	15	—	695	720
65	20	12.5	2.5	>695	720
65	20	9	6	710	730
65	20	5	10	715	745
65	20	—	15	720	753

EF (7a)

Manufacture of Solder in Melting Pots (Zur Herstellung von Lötzinn in Schmelzkesseln). Werner Frölich. *Chemiker-Zeitung,* Vol. 58, Mar. 21, 1934, pages 237-238. Solder is melted in 500 to 2000 kg. pots, usually with hard coal as fuel. If large pots are used they should be heated from the sides as well as from the bottom. The composition varies from 25% to 90% Sn, balance Pb, with 1-1.5% Sb added sometimes to improve the appearance and corrosion resistance. Solder should contain no other impurities, especially no Zn or As. A composition should be selected which will adhere well to the metal being soldered. It should not corrode itself nor cause the parent metal to corrode. For decorative purposes the color of the two metals should be the same. After melting the solder in the pot it should be fluxed with NH_4Cl to deoxidize it, or steam should be passed through it for 3-5 min. Steam removes Zn and As. The metal must not be overheated, usually it is heated to about 300°C. It is generally poured into cast iron molds, and for best results should be allowed to cool slowly. Casting into marble molds produces better appearance. CEM (7a)

Hydrogen Brazing. Fr. Sass. *Mechanical World & Engineering Record,* Vol. 94, Oct. 20, 1933, pages 1015-1017. An alloy of Cu, Ni, and Zn, with a melting-point of approximately 1150°C., is used as welding material. The additions of Ni and Zn are to make the molten welding material somewhat stronger and thicker when in the liquid state, as it has been shown that pure Cu in the molten state is so extremely liquid that it not only penetrates very readily into the narrowest joints, but at times even runs through them without adhering. The hydrogen atmosphere protects parts from oxidation during brazing and subsequent cooling. Parts are automatically annealed by the brazing process so that parts such as cylinder covers leave the furnace entirely free from internal stresses. An electrical furnace for hydrogen brazing is discussed in detail. Kz (7a)

Welding & Cutting (7b)

C. A. McCUNE, SECTION EDITOR

Welding Copper for the Chemical and Allied Industries. Werner Froelich. *Canadian Chemistry & Metallurgy,* Vol. 18, Jan. 1934, pages 13-15. Welding of Cu should not commence at one end and proceed to the farther end of the weld. Starting at a point 5-10 inches away from one end, proceeding to the other end and returning to the starting point to complete the weld to the other end avoids the mechanical stresses always imposed upon rolled or forged Cu section by straight-through welding. Fluxes should not be applied until the surface is red hot. Where hammering is impracticable, careful annealing and chilling of the weld will go far towards balancing mechanical and chemical properties within the section affected. WHB (7b)

Temperature Stresses in Welded Rail Tracks. John Adrian Fargher. *Journal Institution of Engineers of Australia,* Vol. 5, Apr. 1933, pages 122-130. Mathematically investigates the magnitude of the stress forces imposed by variations of temperature on long lengths of rails without expansion joints and the capability of the track in resisting them. It is tentatively suggested that 160 ft. is safe for 80 lbs. track on straight carrying 50,000 lbs. axle loads and 120 ft. for similar track on 10 chains radius curves as maximum, rail temperature variations of 120° F. presumed. For rails in which the stresses due to vertical loadings are less, such as 100 lb. rails carrying suburban traffic, these lengths could be materially increased provided proper care were taken to weld at the correct temperatures and badly injured butting rail ends were eliminated from the expansion joints. In the case of comparatively lightly loaded rails, the governing consideration in determining the maximum length will probably be that of buckling, whereas for more heavily loaded rails, the maximum direct stresses due to the combination of vertical and longitudinal loads will become paramount. 12 diagrams. WH (7b)

Distortions (A Propos des Deformations). R. Granjon. *Soudure et Oxy-Coupage* (Supplement to the Revue de la Soudure Autogène), Vol. 10, Jan.-Feb. 1933, page 169. It is explained that distortions which can be seen are often less dangerous than internal stresses which are not visible. When to prevent distortions heating is made as locally as possible, shrinkage must occur and this can involve small cracks in the vicinity of the welds then, strength can remain the same but ductility of welds is lowered. For these reasons arc welding which reduces distortion is sometimes not to be advocated. It is often preferable to preheat metal to be welded over a sufficient surface. It is wrong to prevent displacement of metal and it is correct to take account of this displacement when adjusting parts to be joined. FR (7b)

Weldable sheet (Les Tôles Soudables.) R. Granjon. *Revue de la Soudure Autogène,* Vol. 2, Oct. 1933, page 2877. Steel seller must take account of requirements of welding industry. Although weldability depends upon many other factors chemical composition allows knowing with sufficient approximation weldability of a steel. Composition for open-hearth steel with good weldability lies within following range C 0.08-0.10, Mn 0.40-0.50, Si less than 0.05, S and P both less than 0.03. It is pointed out that weldability does not depend upon welding process. FR (7b)

Repair of Crankcases Made of Aluminum Alloys (La Preparation des Carters en Alliages d'Aluminum). *Soudure et Oxy-Coupage,* (Supplement to Revue de la Soudure Autogène), Vol. 10, Jan.-Feb. 1933, page 174. Care must be taken in order to take account of expansion and shrinkage. Operator must heat crankcase to be welded slowly up to 400°-450° C. and, after welding, allow the casting to cool slowly. FR (7b)

Manufacture of Gas Bottles by Means of Double Seam Welding (La Construction des Bouteilles à gaz par Soudure Montante à Double Cordon). *Soudure et Oxy-Coupage,* (Supplement to Revue de la Soudure Autogène), Vol. 10, Jan.-Feb. 1933, page 172. Application of the method is explained and illustrated for the manufacture of pressure gas bottles used in the transportation of butane gas. FR (7b)

A Marine Boiler Repair on Tyneside. J. K. Johannesen. *Marine Engineer,* July, 1933, pages 204-206. Discussion of the biggest welding repairs attempted on marine boiler work. The technique followed was in case of vertical and overhead welding as follows: In order to minimize the risk of plate distortion or fracture, a run of metal was placed on each side of the gap, then bridged by a further run and alternate runs deposited thus until the vee was built up solidly. The advantage secured is an equal distribution of heat, refinement of the underlying metal structure, and consequent minimizing of stresses. Kz (7b)

Do You Design or Just "Make" Your Welded Joints? R. Kraus. *Machinery N. Y.,* Vol. 40, Nov. 1933, pages 150-155. To obtain strong, safe and economical welds they must be properly designed, not made by rule of thumb; calculating of stresses is explained, different types of joints and their characteristics illustrated. Ha (7b)

Welding and Weld Material. J. L. Adam. *Iron & Coal Trades Review,* Vol. 128, Apr. 13, 1934, page 605. General points of welding technique are discussed. By building up sufficient material around the joint it is possible to make a joint stronger, that is having greater tensile strength than the parent material with almost any kind of electrode; to find the best electrode is of economical interest. Maximum efficiency in a joint between 2 materials is obtained when the mechanical and physical properties of that joint are exactly the same as those of the parent material. For plates, joints should be flush, and have tensile strength and ductility and capacity to resist shear and alternating stresses equal to the parent material. Uniform distribution of stresses should not be disturbed by the weld. To take full advantage of welding in ship work, joints and connections of plates must be able to withstand alternating stresses of about 7 tons/in.^{2} over long periods or double this amount occasionally without failure. Ha (7b)

Welding of High Quality Valve Steels According to the Fusion Welding Method (Das Verschweissen hochwertiger Ventilstähle nach dem Abschmelzschweissverfahren). K. Baumgärtel & Fr. Heinecke. *Die Elektroschweissung,* Vol. 4, Dec. 1933, pages 228-232. After discussing requirements that steels for valve shafts and seats have to meet (Valve seat steel shall possess high hot tensile strength and corrosion stability, valve shaft steel high resistance to wear and good heat conductivity) different types of such steels (Cr, Cr-Ni, Cr-W, Si-Cr and Cr-Ni-W steels) were electrically welded and tested. The following mechanical tests were made on samples welded: (1) tensile tests at room temperature, (2) hot tensile tests, (3) fatigue tests, (4) microscopic examination. Results show that it is possible to properly join by fusion welding valve steels that meet the above mentioned requirements. Due to the large differences of the specific electric resistance of steels joined certain precautions are required to obtain good results. Good results were always obtained when the shafts, upon welding, were slightly forged and heat treated. With samples thus treated fracture always occurred outside the weld seam. Among the steels investigated joining of Cr steel with Cr-Ni-W steel was most successful. Both of these steels scale but to a very slight extent, Cr steel as shaft material has good wearing properties whereas the austenitic Cr-Ni-W steel used for valve seat steel possesses high hot tensile strength. Valves made of these steels meet highest requirements. For valves subjected to minor abuse the other types of steels may be successfully applied. In using Cr-Ni steel it must be borne in mind that it scales rather considerably and has to be heat treated at other temperatures than the other steels. Since these favorable results were obtained with a manually operated welding machine it is assumed that still better results as regards quality and uniformity of welds will be obtained by applying automatic resistance welding machines. GN (7b)

Application of Monel Metal for Obtaining Machinable Weld Seams with Cast Iron Parts (Verwendung von Monelmetall zur Erzielung bearbeitbarer Schweissnähte bei Gusstücken). *Elektroschweissung,* Vol. 5, Mar. 1934, pages 58-59. In electrically arc welding gray cast Fe parts without preheating weld generally shows a very hard zone that cannot be machined, due to considerable amount of Fe_3C. In using electrodes of Monel metal this disadvantage can be eliminated. Ni, as holds true of Si, decomposes cementite, so that welds thus made can be easily machined, possess sufficient strength and resist oxidation. Monel electrodes are in general coated with flux favoring proper welding process. Welding of gray cast Fe with Monel metal must be made on cold piece in small sections, hammering of weld is advisable. GN (7b)

The Two-Flame-Burner in Practice (Der Zweiflammenbrenner in der Praxis). Ernst Greger. *Der Autogen Schweisser,* Vol. 7, Feb. 1934, pages 19-20. Comparison between the one- and two-flame-burner, crediting the latter with an increase of working speed of 20% and a decrease in gas consumption of 10%. Technique employed in welding of longitudinal seams of large tanks by means of the two-flame-burner is discussed. Kz (7b)

Modern Oxy-acetylene Welding in Pipe Line Construction (Die moderne Autogenschweissung im Rohrleitungsbau). Ernst Greger. *Der Autogen Schweisser,* Vol. 7, Jan. 1934, pages 1-4. Discussion of the welding technique employed in the construction of pipes and pipe connections to obtain: (1) safety and sufficient strength to resist the varying pressures, (2) complete tightness at highest working pressures, (3) elasticity of the weld to suit all heat contractions and expansions of the pipe line and (4) corrosion resistance of the weld. Kz (7b)

Welded Structures Made of Stainless Steels (Les Constructions en Aciers Inoxydables). A. BOUTTÉ. *Revue de la Soudure Autogène*, Vol. 25, Feb. 1933, pages 2705-2706. It is first explained that most commonly used stainless steels i.e. Cr-Ni steel of the 18/8 type which were previously liable to show weld decay owing to structural modification of metal due to heating in the vicinity of welds is now suppressed by additions of special alloying elements, the article illustrates applications of 18/8 steels in welded structures (a) separators of 2.375 meter height and 1.200 meter diameter with plates of 3 mm. thickness, (b) cooler of 11.200 meter length and 3 meter diameter weighing 5,200 kg. FR (7b)

American Regulations on Welding of Boilers and Pressure Vessels (Die amerikanischen Verschriften für die Schmelzschweissung von Dampfkesseln und Druckgefässen). W. BOOS. *Feuerungstechnik*, Vol. 21, Oct. 15, 1933, pages 138-141. A critical discussion on the A.S.M.E. Boiler Code and German specifications on welding of boilers. Safety factor in America = 5, in Germany = 4. Author says that the American standards provide for an annealing treatment of welds below the lower critical point of Fe which relieves only the welding stresses. Except in the case of electric welding with plain electrodes, impact strength and elongation are not impaired by heating to above this temperature limit. Official tests in Germany proved that the same micro-structure can be secured in weld, transitional region and virgin metal by normalizing arc welded seams (coated electrodes) at 930° C. Only in the case of complicated welded constructions annealing should be restricted to 600°-650° C. If the danger of warping prevails long time heat treatments at lower temperatures instead of short time heating to higher temperatures are advised. Recommends Prox's method for testing for the detrimental N_2 in welds by water quenching from 630° C. and cold bending. The impact test specified in the Boiler Code cannot be considered to be such. 7 illustrations. EF (7b)

The Stresses in Fusion Joints. E. G. COKER, R. LEVI & R. RUSSELL. *Proceedings Institution of Mechanical Engineers*, Vol. 124, Apr. 1933, pages 601-643. Deals with problems of plane stress distribution in which models are used for measuring the stress at any point required by photo-elastic means. Analyses experimentally some typical butt welds of an unsymmetrical type. Plates in line are also connected in which the joint is made by a lenticular section of weld metal on one side and a cover plate on the other, the ends of the latter being joined to the main plates by triangular sections of fusion metal. When the gap between the two main plates is sufficient the lenticular section of metal may be replaced by a pair of triangular fillets binding the inner ends of the plates to the cover strap. The effects of triangular fillets of lesser height than the butt straps and of corresponding fillets of curved quadrantal form are also examined with reference to a double butt strap joint. Includes drawings and tables showing locations and amounts of stresses. RHP (7b)

Welded Steel for Engine Structures. EVERETT CHAPMAN. *Mechanical World & Engineering Record*, Vol. 94, Oct. 27, 1933, pages 1039-1040. Discussion of the study of fatigue failures and stress distribution in engine parts. Various kinds of welds are discussed and the stress distribution is studied photo-elastically by means of Bakelite models. The condition of the weld, the endurance value of the weld metal, and the damage to the base metal by the high temperature of the welding operation are touched upon as well as the importance of heat treatment after welding. Places where high stresses may occur in welded construction must be looked for and the effect counteracted. Kz (7b)

You Can Get It from a Weldery. A. F. DAVIS. *Mill & Factory*, Oct. 1933, pages 43-44. Deals with the application of the shielded arc process in the fabrication of machine parts. Discussing the advantages of welding, the various factors promoting savings in replacing cast iron by rolled steel and casting by welding are pointed out by means of examples. Kz (7b)

Suggestions for Welding Manganese Steel. CHAS. ELDRIDGE. *Welding Engineer*, Vol. 19, Mar. 1934, pages 15-16. Some most frequently met with failures in railway switches are pointed out and procedure of repairing or building up the worn part is described. Ha (7b)

Manufacture of Household Utensils by Welding (La Construction par Soudure des Utensiles de Ménage). *Soudure et Oxy-Coupage*, (Supplement to *Revue de la Soudure Autogène*), Vol. 10, Jan.-Feb. 1933, page 174. Application of oxy-acetylene welding is illustrated for cooking utensils and buckets. FR (7b)

Fabricating Stainless Steels (L'assemblage des aciers inoxydables). *Le Soudeur-Coupeur*, Vol. 12, Sept. 1933, pages 1-3. There are 2 main classes of stainless steels—acid resistant, and those resistant to oxidation at high temperatures. In welding stainless steels, their properties and uses must be taken into consideration. Improper welding may accelerate corrosion along the joint. Stainless steels may be joined by brazing without encountering any difficulties greater than those accompanying the brazing of common steels. RRS (7b)

A Beautiful Repair (Une Belle Reparation). R. M. *Revue de la Soudure Autogène*, Vol. 25, Feb. 1933, page 2712. Repair of a large distributing body of hydraulic turbine is explained. Due to shrinkage, a crack about 1 meter long occurred in the cast Fe body. Despite unevenness of section, thickness of casting in the crack zone ranged from 50 mm. to 20 mm. on one side and from 20 mm. to 30 mm. on the other side, repair was successful. Casting was slowly heated up to 600° C., welded with a torch of 2,500 liter capacity and then slowly cooled under protection of air action. FR (7b)

Welding of High Manganese Steels (La Soudure des Aciers a Haute Teneur en Manganese). R. G. *Revue de la Soudure Autogène*, Vol. 25, Feb. 1933, pages 2703-2704. First results obtained by Acieries Electriques d'Ugine which have led to a patent are reported. Up to recent years it was considered impracticable to weld austenitic steel containing 12-15 Mn and about 1% C owing to difficulties due to breakages, cracks, distortions, etc. Numerous added metals had been tried without success. The Acieries d'Ugine have conducted their tests with other austenitic steels than Mn steel. It has been found that 18/8 Cr/Ni steel gives quite good results but, that other types of austenitic steels can also be resorted to. With oxy-acetylene welding no flux is needed. It has been only noted that a carburizing flame is preferred. For arc welding ordinary electrode coating for stainless steels is used. Good results have been obtained in laboratory tests upon test bars. Practical investigations in industrial construction are in progress taking account of special qualities such as low heat conductivity and high shrinkage of base metal. FR (7b)

Dismantles Overhead Bridge by Unique Method. *Railway Engineering & Maintenance*, Feb. 1934, pages 70-71. Pulling down an abandoned overhead interurban bridge onto its tracks by means of a cable attached to a locomotive and then dismantling the structure with oxy-acetylene torches in about 2 hours for $700 or 1/5 the cost of doing the work on falsework. WH (7b)

Building and Industrial Pipe Welding Practice. *Oxy-Acetylene Tips*, Vol. 13, Apr. 1934, pages 77-82. Advantages and disadvantages of shop-fabrication where a large part of the piping is welded in units and carried to the place of erection, and fabrication on site where the pipe is delivered to the job and all work carried out there, are discussed. The decision which of the 2 methods should be applied depends on individual conditions in each case. A few examples are described to illustrate the important points. Ha (7b)

Strong Welds for Strong Steel. *Oxy-Acetylene Tips*, Vol. 13, Mar. 1934, pages 59-60. Cromansil steels (0.4-0.6% Cr, 1.1-1.4% Mn, 0.7-0.9% Si, 0.1-0.25% C) are satisfactorily welded with oxy-acetylene. Procedure and welding rods used are described for material of different thickness (1/16" to 3/4"). Ha (7b)

The Use of Rolled Steel in Machine Construction. H. G. MARSH. *Yearbook American Iron & Steel Institute*, 1933, pages 76-126; discussion, pages 127-141; *Iron & Coal Trades Review*, Vol. 126, June 9, 1933, page 892; *Industry & Welding*, Vol. 6, July 1933, pages 2-6, 22-28; *Engineer*, Vol. 155, June 9, 1933, pages 585-586; *Metal Stampings*, Vol. 6, June 1933, page 167; *Steel*, Vol. 92, May 29, 1933, pages 25-27; *Iron Age*, Vol. 131, June 1, 1933, pages 860-861. The development of welding has resulted in the extensive use of rolled steel in place of castings. This development in all its phases is discussed and illustrated by numerous pictures of welded construction.

VVK + Ha + LFM + MS + VSP (7b)

Study of Flames at Very High Temperatures (Sur l'Etude des Flammes aux Tres Hautes Temperatures). G. RIBAUD & D. SÉFÉRIAN. *Revue de la Soudure Autogène*, Vol. 25, Oct. 1933, pages 2879-2889. Paper at the 3d Congress of Industrial Heating, Paris, Oct. 9-14, 1933. Following problems are dealt with (1) Study of atomic H flame (a) Study of dissociation as a function of temperature, (b) change in H dissociation with pressure, (c) shape of the flame, (d) spectographic study of the atomic H flame, (e) temperature of the atomic H flame. (2) Study of the oxy-acetylene flame (a) distribution of temperature within the flame, (b) study of combustion products, (c) computation of dissociation fractions, (d) computation of temperatures. 23 references. FR (7b)

How a Large Shipyard Conducts Welding Operations. G. H. MOORE. *Marine Engineering & Shipping Age*, Vol. 39, Mar. 1934, pages 101-105. Deals with the application of the different welding methods and oxy-acetylene gas cutting in marine construction and repair work. To illustrate the extent to which these are used figures are given and examples discussed. Kz (7b)

Tests for Training Welders. C. A. OAKLEY. *Mechanical World & Engineering Record*, Vol. 94, Oct. 13, 1933, pages 982-983. Discussion of methods and devices applied for testing electric welders during their training. Kz (7b)

Diesel Structures. EVERETT CHAPMAN. *Marine Engineering & Shipping Age*, Vol. 38, Sept. 1933, pages 330-333. See "Welded Steel Diesel Structures," *Metals & Alloys*, Vol. 5, May 1934, page MA 198. Kz (7b)

Welding for Maintenance. *Mill & Factory*, Sept. 1933, pages 32-34. Discussion of specific examples showing how substantial savings have been effected by reclaiming worn or broken parts with the oxy-acetylene process. Particulars concerning welding rods, welding time, cost, and the welding technique employed in the different cases are given. Kz (7b)

Johnston Tube Welding Process (Das Johnston Rohrschweissverfahren). *Die Metallbörse*, Vol. 23, Nov. 18, 1933, pages 1469-1470. Detailed description of Johnston tube welding process and 3 tables collecting data gained on bursting and pulling tests on various tube gauges. EF (7b)

Navy Boiler Drum Practice Used for Fusion Welded Pipe. *Marine Engineering & Shipping Age*, Vol. 39, Feb. 1934, pages 52-55. Deals with the fabrication of fusion welded plate steel pipes of from 8.5-30 ft. diameter from plates of up to 2¼" thickness. Description of welding equipment for automatic welding of plates formed by a vertical plate bending roll. After examination by a 300,000-volt portable X-ray equipment, which makes a permanent photographic film of every inch of the weld, the pipe sections are placed in a furnace for 1 hour/in. thickness. Kz (7b)

Developments in Automatic Arc Welding. *Machinery, London*, Vol. 43, Jan. 11, 1934, pages 435-440. After dealing with the fields of application for metallic and carbon arc welding, the means of preventing carburization of welds are mentioned. Costs of welding by the 2 processes are compared and attempts to control arc stability are touched upon. The "Arcatom" and "Arcogen" processes are discussed and the importance of covered electrodes is stressed. Dealing with the "Agil" alloying method of welding, welding times and current consumption with this process are presented in a table. After discussion of the a.c. arc welding, the advantages of automatic arc welding are pointed out. The Siemens-Schuckert automatic metallic arc welder and the A.E.G. automatic longitudinal seam welder are discussed in more detail. In conclusion automatic arc welder for rear-axle housings and a welding plant for reconditioning railway wheel sets are described. Kz (7b)

Time Effect after Welding. *Journal of Commerce (Shipbuilding & Engineering Edition)*, Apr. 12, 1934, pages 1, 5. A discussion on whether ordinary methods of electric welding offer opportunities for deposited metal to be subjected to strains and deformations, after welding has been completed, and while the metal is at a dangerously low temperature, such as would bring the weld metal into a state comparable with that of steel, which has been cold-worked, and thus render it liable to aging with a deterioration of its physical properties. JWD (7b)

Electrodes for Ship Welding. *Journal of Commerce (Shipbuilding and Engineering Edition)*, Jan. 11, 1934, pages 1, 2. A discussion on the differences between electrodes with heavy and light coatings favors the production of high grade electrodes capable of being worked with the formation of a minimum of slag, which can be easily and completely removed without special treatment. JWD (7b)

Modulation Welding, a New Process for Welding Seams. *Engineering Progress*, Vol. 14, Oct. 1933, pages 192-193. Describes a process devised by the A. E. G. of Berlin in which the voltage is made to fluctuate constantly between a maximum and a minimum value. Has all the advantages of the spot-welding process, but does not require the current interruption previously required in continuous welding. This diminishes the wear of the interruptor. RHP (7b)

Special Spot-Welding Machines. *Engineering Progress*, Vol. 14, Oct. 1933, pages 201-202. Briefly describes several German spot-welding machines, some traveling, and some stationary. RHP (7b)

Repairs to Oil Engine Parts by Welding. *Diesel Engine Users Association*, S. 118, Dec. 13, 1933, 6 pages. A discussion taken part in by a number of speakers deals with repairs to such parts as cylinder heads, exhaust valve levers, piston covers, cylinder covers and cylinder casings with special reference to the technique of the welding and the efficiency of the work done. JWD (7b)

Testing Laboratory for Welding Technique of the Chemisch-Technische Reichsanstalt (Versuchsfeld für Schweisstechnik der Chemische-Technischen Reichsanstalt, Berlin). *Autogene Metallbearbeitung*, Vol. 27, Mar. 1, 1934, pages 71-74. Describes building, equipment and testing apparatus. Ha (7b)

Standards for Resistance Welding Apparatus. *American Institute of Electrical Engineers, AIEE*, No. 39, Jan. 1934; *American Standards Association, ASA* C52.2-1933, 10 pages. AHE (7b)

Standards for Electric Arc Welding Apparatus. *American Institute of Electrical Engineers, AIEE*, No. 38, Jan. 1934; *American Standards Association, ASA* C52.2-1933, Sept. 6, 1933, 11 pages. AHE (7b)

Machine Gas Cutting. Air Reduction Sales Co., New York. Paper, 8½ x 11 inches, 92 pages. Numerous little-known possibilities within and outside of the field of welded steel fabrication are revealed in an ingenious "illustrated interview" style of exposition, supplemented by 2 full-page tables each in 3 parts, giving for 23 thicknesses the machine set-up, the consumption of 0 and of acetylene per hour, per linear ft. and per 100 in.² cut, and the gas costs of such operations. Typical examples are adduced from railroad shops, boiler works, shipyards and various classes of machine shops. Second half of book is devoted to the makers' line of machines said to "cover the entire range of flame cutting," each type being described in its essentials and with various attachments for special purposes, limitations of each being given diagrammatically and stated in the text.

M. F. Behar (7b) —B—

Carbon the Enemy of the Welder (Le Carbone ennemi du Soudeur). R. GRANJON. *Revue de la Soudure Autogène,* Vol. 25, Mar. 1933, page 2725. It is pointed out that steel with best weldability contains 0.05-0.10% C, that C content must not go over 0.15% or it is necessary to introduce Si, but not in too high amount, in order to prevent C oxidation. This point is actually studied. When it is necessary to have high strength steels, strength is obtained by Mn, Ni, Cr, Mo. etc. . . . additions but not by increasing C content. FR (7b)

Oxygen the Enemy of the Welder (l'Oxygene ennemi du Soudeur). R. GRANJON. *Revue de la Soudure Autogène,* Vol. 25, Apr. 1933, page 2745. Taking account of an answer he has received from Prof. Guichard about a previous article on "Carbon the Enemy of the Welder," the Author points out that of course correct welds can be obtained with a C content as high as 0.15% provided that weld is made under reducing atmosphere. However C has disadvantage to build with Fe an alloy which is much affected by heating. It remains true that in steel of good weldability C must be kept low and, when necessary, strength of metal is improved by alloy such as Cr, Ni, Mo, V, additions. FR (7b)

Dimensioning of Welded Steel Profiles (Zur Bemessung geschweisster Stahlbauquerschnitte). H. GOTTFELDT. *Die Elektroschweissung,* Vol. 5, Mar. 1934, pages 52-55. Whereas the most important constructural and joining element of riveted constructions are angle shapes properly designed welded constructions are distinguished by predominating use of flat shapes. Author describes a new method, utilizing drawings, in order to comprehend the relations between load carrying capacity and dimensions of welded constructural elements made of flat Fe shapes. The method is described for I, T and tubular cross-sections. GN (7b)

Fusion Filler Welding of Crossings (Auftragschweissung an Herzstücken). FRIEDRICH GOLLING. *Der Autogen Schweisser,* Vol. 6, Nov. 1933, pages 129-132; Vol. 6, Dec. 1933, pages 145-150. Experiences gained by employing arc-welding and oxy-acetylene welding for repairs of rails and switches by means of the fusion filler metal process are discussed. Better wear resistance and greater economy are the advantages of the application of the oxy-acetylene welding. Details of the technique employed and costs are furnished. Metallographic investigations show that the structure of rail material and fusion filler metal is the same and Brinell tests prove the equality in hardness of both. Periodical inspections showed only signs of normal wear but no cracks or chipping off as experienced with arc welded repairs. The pressure of the train wheels caused a remarkable increase in hardness of the fusion filler metal (from 250 to 352 and from 253 to 311 respectively). Kz (7b)

Fusion Welding in Automobile Repairing (Autogenes Schweissen bei der Autoreparatur). H. GAVANDA. *Der Autogen Schweisser,* Vol. 7, Jan. 1934, pages 6-7. Discussion of technique employed in welding parts made from Al, Al alloys, and Pb. Details are furnished dealing with repairing of batteries, crankcases, and Al sheet metal. Kz (7b)

Welding Meeting (Sprechabend für Schweisstechnik des Fachausschusses für Schweisstechnik im Verein Deutscher Ingenieur in Düsseldorf am Montag, den 26. Februar d.J.). HESSLER. *Die Wärme,* Vol. 57, Mar. 24, 1934, pages 197-198. Leitner states that the welding speed greatly affects the physical properties due to varying N_2 and O_2 absorptions:

Welding speed in m./hr.	6	12	18
Tensile strength in kg./mm²	47-53	59-65	68-75
Brinell Hardness in kg./mm.²	44-47	48-52	50-55

Higher welding speeds involve larger gas absorption. Rapid cooling of the weld causes N_2 to remain in solution or to precipitate in finely distributed manner which scarcely affects the physicals of the weld. The current intensity has also a bearing on the N_2 precipitation. Data gained on 10 mm. sheets welded at 5 m./hr. show the following interrelation:

Current intensity in amps.	140	160	180	200	220
Brinell Hardness in kg./mm.²	63	56	52	51	48

A higher current intensity apparently promotes a more favorable form of N_2 precipitation. Higher welding speed involves greater porosity with uncoated electrodes. Special electrodes with "Schlackenseele" (4-10% alkalines and other additions to the rod) permit speed of 50 mi./hr. and yield a more stable arc. The following interrelations concerning the arc length was established.

Arc length in mm.	Current in amps.	Welding rod deposit in g./min.	N_2 content in %
3	220	49	0.092
7	210	47	0.101
13	185	41	0.123

A maximum arc length of 5 mm. is advised. The favorable action of Cr, Mn and Ni in welding rods is pointed out. Stursberg reports on acetylene welding of ingot steel of higher C contents. Experiments showed that peak values of strength are obtained with an excess of 10% acetylene (0.5-0.6% C in the weld). However elongation and impact strength are impaired. The best combination of physicals was secured with an acetylene excess of 2-3%. EF (7b)

Welding rods for German silver alloys (Schweissdraht für Neusilberlegierungen). F. HERGER. *Zeitschrift für Schweisstechnik,* Vol. 24, Jan. 1934, pages 6-9. Fusion welding of German silver has heretofore been considered almost impossible but it is now possible to weld all the various German silver alloys by use of "Sildo." Extensive practical tests have been made on various kinds of German silvers, which have appeared under dozens of trade names, and have shown that the welds can be made practically free from pores. The most familiar of the German silvers that were tested are: "Rausilber" and "Neusilber L 3." The "Sildo" rod contains Cu, Zn, and Ni, as well as small amounts of Si and Ag. The author describes the method of welding and gives illustrated descriptions of six applications. RRS (7b)

Oxy-Acetylene Welding for Porcelain Enameled Metal. L. B. HART. *Enamelist,* Vol. 11, Mar. 1934, pages 9, 12. Enameled metal should be welded with the long, outer section of the torch flame which contains water vapor and CO_2 only; the short, blue section of the flame must never come in direct contact with the molten metal as it contains gaseous hydrocarbons which are easily absorbed by the molten metal and make a porous weld. General instructions for welders are given. Ha (7b)

Copper Welding Applied to Locomotive Repairs. FRANK HUGH HARRISON. *Journal Institution of Engineers of Australia,* Vol. 5, Oct. 1933, pages 332-340. Describes the Cu welding process which has been developed at the Islington Workshops of the South Australian Railways and its application to the repair of Cu fire boxes. It is shown, by overcoming the great difficulties of welding Cu and thus effecting repairs in positions previously inaccessible, considerable savings have been effected over a period of 3 years. Emphasis is laid upon the fact that trained operators are essential for the production of successful work. German locomotive repair shops utilize a filler rod made of a special alloy of Cu, Ag and P using a special flux, whereas electrolytic Cu without a flux is generally used in France. To weld 9/16 in. plate in steel a torch consuming about 35 cu. ft. of acetylene and oxygen/hr. suffices as compared with 2 torches with a combined consumption of 150 cu. ft. of C_2H_2 and 145 cu. ft. of O_2/hr. which are essential to get quick heat and quick deposition of weld rods. Each torch is fed from separate sources and the strictly neutral flame must be regulated continuously to prevent the formation of cuprous oxide in the weld metal. Excessive C_2H_2 results in welds low in tensile strength and ductility due to C absorption. Difficulties in securing sufficient heat to reach the welding temperature are pointed out. At no time should the metal be touched by the oxygen cone. The welded surface must be entirely covered by the flame to exclude atmospheric O_2. After solidification the weld should be hammered. The practical application of the process is shown in 16 typical illustrations and testing methods are dealt with in very great detail. WH (7b)

Application of Correct Design, Good Welding, and Field Testing to Structural Work. ROB. S. HALE. *Welding Engineer,* Vol. 19, Jan. 1934, pages 21-23. Original design, good appearance, in connection with speed in erection, stiffer structures can be realized by use of welding in building trades. Simple methods are described for testing welds in the field. Ha (7b)

1

Research on Welding (Travaux et Recherches). *Revue de la Soudure Autogène,* Vol. 25, Feb. 1933, page 2706; Mar. 1933, page 2733; Oct. 1933, page 2891; Apr. 1934, page 2762. Short account of tests which are in progress at the "Office Central de l'Acetylene"; (1) Welding of "Everdur" alloy. (2) Tests on fluxes. (3) Coating of worn parts with alloy steels. (4) Oxy-acetylene welding of very thick plates. (5) Use of butane gas (C_4H_{10}) and propane gas (C_3H_8) in welding torch: It is concluded that these gases cannot be advocated for welding. Flame obtained is always oxidising which does not allow sound welds on most of alloys. (6) Test on high strength light alloys; Tests made on new alloys "Avial" and "Margaluma" show that as for all other light alloys, strength of these alloys is lowered by welding and that a correct heat treatment must be 2 applied after welding. (7) Corrosion tests on welded test bars: a new apparatus is installed at the Office Central for immersion corrosion tests. (8) Fusion welding of Ni: Tests have shown that quality of Ni has been much improved in recent years. A complete technique of welding has been developed which will be soon published. (9) Logical use of various added metals: A series of 6 or 7 compositions of added metal seems to be sufficient to weld usual structural steel having a strength of 40-60 kg/mm². (10) Welding of nickel silver: tests have shown that blows are invariably present in welds on metal containing Pb even in very small quantities. (11) Tests on added metal for welding Cu: new products proposed by manufacturers would have but little advantage over Cu as added metal. (12) Welding of 13% Mn steel: Welding of this steel shows progress and chain links and pressure vessels are already welded in practice. (13) Welding 3 of stainless steels with Sn: Despite difficulty of Sn plating of stainless steels, it would be possible to perform soft welding with them provided that a good flux such as pure phosphoric acid is used. FR (7b)

Rail Welding; Build-up welding of frogs and crossings (Schienenschweissung, Auftragschwessung von Herzstücken und Kreuz). *Zeitschrift für Schweisstechnik,* Vol. 24, Jan. 1934, pages 14-16. Describes the welding method, using a welding rod containing approximately 0.6% Mn and 0.8% Cr. RRS (7b)

18-Foot Welded Steel Sphere Serves as Boulder Trap on New Dredge. *Steel,* Vol. 93, Nov. 6, 1933, page 27. Sphere, weighing 31 tons, is constructed of 1¼" plates joined by butt-welding. Shielded arc process was used in welding. MS (7b)

4

Welding Processes Receive Much Wider Acceptance. *Steel,* Vol. 94, Jan. 1, 1934, pages 124-125, 134. Reviews developments in the welding industry in 1933. Outstanding ones were improvement in weld quality; precision control in the resistance process; improvement in welding stainless steel and Al; further perfection of flame machining; more general acceptance of welded structures; adoption of new codes; and more extended use of X-ray inspection. Progress was achieved also in riveting. MS (7b)

Distortions in Vessel Welding (Les Déformations en Chaudronnerie Soudée). *Soudure et Oxy-Coupage,* (Supplement to Revue de la Soudure Autogène). Vol. 10, Jan.-Feb. 1933, page 170. It is shown that with oxy-acetylene welding it is necessary to prevent distortions by using punch marks and careful operation. Best operation for each type of joint is given. FR (7b)

5

The Electric-Arc Welding Process. WILLIAM BARR. *Iron & Coal Trades Review,* Vol. 128, Apr. 6, 1934, pages 563-564. The more important factors which influence the properties of the weld deposit, particularly with reference to ductility and toughness in structural work, are discussed. Correct and uniform temperature conditions to give a smooth and controllable flow of metal under a steady arc of minimum length, proper distribution of heat between electrode and material to obtain the required penetration at the junction of weld deposit and material without overheating the material itself, and deposition of material from coated electrodes in such manner as to facilitate removal of slag between successive runs, are considered essential factors in obtaining a sound weld. Contamination by nitrogen, age-hardening, and microstructure is discussed. Ha (7b)

6

High-speed Welding. THOMAS E. BERRY. *Electrical Review,* Vol. 114, Mar. 2, 1934, pages 303-304. Discusses high-speed arc welding of plates, a process recently introduced into Great Britain. MS (7b)

Skillful Design Is Essential for Welded Design. L. J. BROWN. *Machine Design,* Vol. 5, Sept. 1933, pages 18-22. Welding is not necessarily the most economical production method. As much or more care is required for design of parts to be produced by this process as by others. To achieve low cost in a welded structure, welding should be used sparingly. Right angle welded joints should be replaced wherever possible by the use of rolled steel sections. Practical examples of limited amount of welding in key positions and critical points are 7 given. Accessibility of the joints is important. The time-consuming placing and holding the parts in the proper assembly relation preparatory to welding must be considered. Further costs eventually introduced by welding are: turning over of structure, straightening operation due to shrinkage distortions, annealing for stress removal. A lengthy discussion on practical experiences gained on welding of machinery bases or bedplates is included. WH (7b)

Review of Literature on Fusion Welding (Revue de la Presse de la Soudure Autogène). JEAN BRILLIÉ. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 4, Aug.-Oct. 1933, page 1039. Account given before the French Welder's Society. Subjects dealt with are the following ones: (1) Building Construction (*The Welder,* May 1933 and *Journal American Welding Society,* Mar. 1933, Jul. 1933.) (2) Vessel and Boiler Making (*The Welder,* Mar. 1933, June 1933. 8 *The Welding Engineer,* Jan. 1933, Feb. 1933, May 1933, and *Electric Welding,* Aug. 1933). (3) Naval Engineering (*The Welder,* Apr. 1933, *Electric Welding,* June 1933). (4) Miscellaneous. FR (7b)

The Increasing Versatility of Welded Repairs in Marine Engineering. C. W. BRETT. *Marine Engineer,* Nov. 1933, pages 327-328. After mentioning the repairs of boilers, oxy-acetylene welding of a triple-expansion marine engine is discussed. The average thickness of the affected metal was 3 in., and the total length of the welds 14 ft. 6 in. Dealing with Diesel engine repairs, the rectifying of cracks across the cylinder heads and the repair of shafts by means of the building-up process are discussed. Besides propeller repairs, such as replacing a blade, building-up and re-machining of the boss, some other examples of the 9 application of welding to marine engines are dealt with. Kz (7b)

Advances in Metal Surgery. C. W. BRETT. *Gas Journal,* Vol. 204, Nov. 8, 1933, pages 410-411. There is no metal which cannot be welded. Cast Fe and malleable parts can be repaired by fusion at temperatures no higher than those commonly used in brazing. The danger from distortion at the higher temperatures used for heavier sections has been eliminated. MAB (7b)

Welding Aluminum with the Metallic Arc. JOHN J. BOWMAN. *Machinery, N. Y.,* Vol. 39, Feb. 1933, pages 403-406. The electrodes must be coated by a flux. Coating thickness of about 0.035 inch on ⅛ inch electrodes grading down to about 0.025 to 0.030 inch on ¼ inch electrodes. The flux when molten should be able to attack and remove any oxide film, the molten flux, with the dissolved or suspended Al_2O_3, should have a specific gravity below that of molten Al 10 so that it will come to the surface of the weld very quickly, it should not be too deliquescent, should bind together well, and produce a good coating on the electrode, melting point of the flux should be slightly lower than that of Al, and the flux should be relatively stable at these temperatures. Discusses method of applying flux to electrode, welding procedure, suitable electrodes, porosity in welds, method of finishing weld, and strength of welded joints. RHP (7b)

FINISHING (8)

H. S. RAWDON, SECTION EDITOR

How Attractive Finish Helps Metal Products Sales. II. The Problem of Selection. HERBERT R. SIMONDS. *Iron Age*, Vol. 132, Nov. 9. 1933, pages 16-19, 60. **III. Cost and Value of Cleaning.** *Iron Age*, Vol. 132, Nov. 23, 1933, pages 12-15, 52. II. Describes some of the difficulties in solving the selection and a few of the new developments in metal finishing, such as plating, lithographing, veiling, etc. III. Discusses reasons for cleaning and selection of cleaning method, with cleaning costs. VSP (8)

Pickling (8a)

Inhibitors. F. P. SPRUANCE. *Wire & Wire Products*, Vol. 8, Oct. 1933, pages 328-329, 342. The purpose of an inhibitor is to save acid in pickling by preventing unnecessary exhaustion of the pickle bath by dissolving steel after scale has been removed, but it must not slow the pickling and must not leave stains or other objectionable features on the pickled material. Methods for economic procedure in pickling are discussed. Ha (8a)

How Attractive Finish Helps Metal Products Sales. VI. Pickling for Better Finish. HERBERT R. SIMONDS. *Iron Age*, Vol. 132, Dec. 21, 1933, pages 18-20, 58. **VII. Pickling as a Manufacturing Process.** *Iron Age*, Vol. 133, Jan. 4, 1934, pages 14-17; Jan. 11, 1934, pages 14-17. VI. The importance of pickling is stressed. Pickling in some form is a usual operation before annealing, lacquering, japanning, tinning, or plating, and is common practice in most other types of metal finishes. Scales are classified as: (1) Hydrated ferric oxide; (2) Anhydrous ferric oxide; and (3) Magnetic oxide. Removal of scale by pickling is not so much by dissolving the scale itself as by mechanical action set up between scale and base metal by acid solution. Recently electrolytic descaling has been greatly developed by the introduction of a Si alloy anode. Acids and the proper containers are discussed. VII. Deals with the importance of pickling in production of attractive metal finishes. Acid brittleness, electrolysis, new economies, continuous process of pickling, and proper location of pickling units are discussed. VSP (8a)

De-scaling Forgings by Tumbling in Weak Acid. N. RANSOHOFF. *Metal Progress*, Vol. 25, Mar. 1934, pages 35-37. Tumbling small forgings with hardened stainless steel stars, steel grit and weak acid results in very effective removal of all scale at lower cost than previously used methods. Separation of the stars and grit from the charge is effected automatically and they are dumped into a neutralizing bath and then a drying vat. WLC (8a)

Acid Pickling of Iron and Steel Components. *Synthetic & Applied Finishes*, Vol. 4, Feb. 1934, pages 330-331, 345; Mar. 1934, pages 361-367; Vol. 5, Apr. 1934, pages 21-23. The following factors enter into pickling problems: metal, acid, temperature, time. Importance of degreasing is stressed. Non-inflammable chlorinated hydrocarbons, and hot alkali cleansers are considered critically. Si steels (1-4% Si) are pickled similarly to the mild steels; for Si-irons with 12-15% Si HF should be added to the pickling bath. Stainless, heat resisting alloys of Cr, Cr-Ni, and Cr-Ni-Mo are usually restricted to a H_2SO_4 base pickle, with additions of HCl, HNO_3 or both in some cases. 20-25% H_2SO_4 solutions at 20°C. are most economical; for elevated temperatures lower concentrations are preferable. 8 diagrams correlate pickling time, acid concentration (H_2SO_4, HCl with and without inhibitors) and temperature with reference to "cold rolled and close annealed Welsh plate" and hot black rolled mild steel. A wide latitude may be allowed for pickling mild and medium C steels, wrought and malleable irons, straight Si alloys and simple Fe-Ni alloys: preferably 5-10% H_2SO_4 at 60°-80°C., or 10-20% HCl at 40°-80°C. A good general cleaner for martensitic steels (magnetic varieties) comprises 17% H_2SO_4, 3% HCl, 0.01-0.10% inhibitor, used at 60°-70°C; and for austenitic steels: 20% HCl, 8% HNO_3, up to 0.5% inhibitor used at same temperature. A brighter appearance is produced by a final quick rinse with warm HNO_3 (30-35%). Silicious matter is removed from sand castings by solution containing 5% H_2SO_4 (or eventually HCl), 5% HF, 0.01-0.1% inhibitor. Washing operations and control of pickling baths are fully dealt with. EF (8a)

Cleaning, including Sand Blasting (8b)

Blast Cleaning in the Metal Industry. WM. A. ROSENBERGER. *Machinery*, N. Y., Vol. 40, Feb. 1934, pages 353-356. Various applications of blast equipment for cleaning and finishing metal objects in all branches of industry are reviewed. Apparatus, ventilating and dust collecting systems are described. Ha (8b)

Clean Surfaces Essential in Protective Coating of Steel. KARL DAEVES. *Iron Age*, Vol. 132, Sept. 14, 1933, page 43. Abstract of paper read before the Electrochemical Society at Chicago. Paint and Zn coatings show considerably better adhesion to Cu steel than to ordinary steel. Surface condition exerts a profound influence on life of paint applied to metal, particles of blue mill scale being particularly objectionable. VSP (8b)

Removing Rust from Steel Structures. *Railway Engineer*, Vol. 55, Feb. 1934, pages 33, 38-39. Data on performance and cost of pneumatic chipping and sand-blasting on the German State Railway. Chipping tool weighs 4 lb. 6 oz., works at 59-88 lbs./in.² pressure and delivers 3,600 blows/min. Air pressure for sand-blasting equipment varies between 37 and 88 lbs./in.² A portable compressor for both is shown. Specially prepared quartz sand, though more expensive, gives better results than river sand consisting of .06-.08 in. particles. Steel grit is now used to a considerable extent, but its higher cost is justified only if it can be collected and used several times. According to data presented sand blasting is more economical than manual derusting. WH (8b)

Polishing & Grinding (8c)

The Grinding Wheel (Die Schleifscheibe). R. BOCK. *Oberflächentechnik*, Vol. 11, May 1, 1934, pages 103-104. Materials and binders for making grinding wheels and their operation and handling are discussed. Ha (8c)

Extreme Accuracy in Large Roll Finishing. E. H. BERGES. *Iron Age*, Vol. 132, Nov. 15, 1933, pages 14-16, 51. Describes methods used to produce extremely accurate rolls by the Farrel-Birmingham Co., Inc. One recent product, a calender roll 405 in. long, is probably the largest of its kind ever produced. VSP (8c)

Grinding Small Components. *Automobile Engineer*, Vol. 24, May 1934, pages 181-182. A special grinding machine for grinding small pieces from 0.02" up to 1.2" diam. and length up to 7.9" is described. Ha (8c)

Electroplating (8d)

Platinum Plating of Noble and Base Metals (Zur Platinierung edler und unedler Metalle). EDMUND R. THEWS & RALPH W. HARBISON. *Chemiker-Zeitung*, Vol. 57, Dec. 13, 1933, pages 980-981. Pt plating properly done on Ag increases the life 60 to 70% over that of Ag and is also better than Au. The thickness of Pt coating should be 1/20 to 1/15 the thickness of normal Ag coating. The cost is 4 to 5 times that of Ag. Pt plated articles used in kitchens often darken with use due to SO_2 attack, unless the coating is heavy. In Pt plating, insoluble anodes must be used. Pt is introduced in the form of salts, $PtCl_2$ or Pt $(NH_3)_2(NO_2)_2$. The solutions have very good throwing power. Pd and Rh plating are similar to Pt plating. CEM (8d)

Chromium Plating Increases the Life of Tools and Dies in Automotive Plants. CHAS. O. HERB. *Machinery*, N. Y., Vol. 40, May 1934, pages 536-537. Cr-plating proved of great advantage in improving the wear-resistance of reamers. Procedure of plating new and replating worn tools is described. Ha (8d)

1 **Analytical Control of Cadmium Electro-plating Solutions.** E. E. HALLS. *Metallurgia*, Vol. 9, Apr. 1934, pages 183-184. Gives directions for analyzing Cd plating solutions. JLG (8d)

Theory of Fusion Electrolysis (Zur Theorie der Schmelzflusselektrolyse). P. DROSSBACH. *Zeitschrift für Elektrochemie*, Vol. 40, Apr. 1934, pages 180-182. Theoretical considerations show that the e.m.f. at the bath (voltage of disintegration or polarization) is not as important for electrolysis in a fused mass as in aqueous solutions, as this e.m.f. is reached only under extremely high current densities and quite definite conditions. When giving polarization voltage the exact dimensions of the bath should be given as this determines the current yield of the process. Ha (8d)

2 **Chromium Plating Literature. (XXIV).** L. H. DECKE. *Plater's Guide*, Vol. 30, Apr. 1934, pages 13-15. General references. WHB (8d)

Spotting of Electroplated Materials (Zur Fleckenbildung auf elektro-plattierten Materialien). WERNER FRÖHLICH. *Die Metallbörse*, Vol. 24, Feb. 10, 1934, pages 177-178. Flaws and pores are blamed for spotting. Pickling in H_2SO_4 prior to electroplating leaves traces of acid in minute cracks which later attack the electro-plated material from the inside. Other causes are external. An alkaline rinse, preferably hot soda lye + NH_3, after plating is strongly advised for removing all cyanide. This is followed by washing with water. Tri-sodium phosphate and tartaric acid (volatile) exert the same effect. The fact that thicker electro-deposited coatings exhibit more pronounced spotting is ascribed to the difficulty of washing
3 out the deeper pores. Slag inclusions in steel and rusting beneath flaws in the plating are other causes of spotting. EF (8d)

An Optical Method for the Investigation of the Concentration Polarisation During Electrolysis (Eine optische Methode zur Untersuchung der Konzentrationspolarisation während der Elektrolyse). A. G. SAMARCEV. *Zeitschrift für physikalische Chemie*, Abt. A, Vol. 168, Feb. 1934, pages 45-58. An optical method based on the use of the polarisation interferometer of Lebedev is described for measuring the concentration polarisation during electrolysis of Cu and Ag in its aqueous sulphate and nitrate solution respectively. The concentration distribution in the diffusion layer and the thickness of this layer has been determined under various electrolysis conditions. The equation expressing the relation between concentration
4 gradient at the electrode surface and current density during electrolysis has been experimentally corroborated. Diffusion coefficients for the electrolytes employed have been determined. The total polarisation of the cells Cu|$CuSO_4$. aq|Cu and Ag|Ag-NO_3 . aq|Ag is larger than the concentration polarisation. EF (8d)

Electrolytic Deposition of Nickel in Solutions of pH Values Above 7.0 (Le Dépot Électrolytique du Nickel en Milieux de pH Superieur à 7.0). MARCEL BALLAY. *Comptes Rendus*, Vol. 198, Apr. 23, 1934, pages 1494-1496. Good Ni deposits were obtained at 40° C., 2-10 amp./dm.², pH 3.6-9.8 with following solution: Ni 20.8 g/1, NH_4 6.3, Cl 6.0, neutral Na citrate 150. Glycollic and lactic acids aid in Ni deposition but other organic compounds, such as malic and tartaric acids, glucose, maltose and glycerine are not satisfactory. FHC (8d)

5

Metallic Coatings other than Electroplating (8e)

The Silvering of Automobile Headlamp Bulbs. GEORGE S. SANTMYERS. *Metal Industry*, N. Y., Vol. 31, Aug. 1933, pages 277-279. Details in the preparation of lamps and of stock solutions are given. Use of excess ammonium hydroxide in the preparation of the silver solution, elimination of filtering and production of a very opaque deposit in a dilute solution of silver by means of I_2 or of the double cyanide of Hg and K represents a method of silvering glass in general that may be of interest. PRK (8e)

6 **Essential Characteristics of Sprayed Metal Coatings (Die wesentlichen Merkmale gespritzter Metallüberzüge).** H. REININGER. *Zeitschrift für Metallkunde*, Vol. 25, Nov. 1933, pages 286-288. Continuation of previous articles (ibid. pages 42-44, 71-73). Micrographs are given of iron sheet sprayed with Al, Sn, brass, and Zn; of Al sheet sprayed with Fe and Sn. Methods of studying coatings and heat treatment of coatings are described. RFM (8e)

Review of Rustproofing Processes with Reference to the Use of Town's Gas. O. W. ROSKILL. *Metallurgia*, Vol. 9, Apr. 1934, pages 185-188. Describes degreasing process and a number of rust-proofing processes. JLG (8e)

Aluminum Coats on Iron Made by Fusion (Im Schmelzfluss hergestellte Aluminiumüberzüge auf Eisen). H. ROEHRIG. *Oberflächentechnik*, Vol. 11,
7 May 1, 1934, page 100. The different methods of coating Fe with Al are discussed. To obtain proper diffusion of Al in Fe, Al must dissolve with formation of Al_3Fe which diffuses into Fe by forming a solid solution. Four layers are distinguished: the unchanged Fe, the intermediary layer of Al_3Fe, a layer infiltrated with Al_3Fe, and the covering layer. The adhesion of the coating is the better the thinner the brittle intermediary layer Al_3Fe and the purer the Al covering layer is. C in Fe retards diffusion. Increasing temperature increases thickness of Al_3Fe layer; the Al layer does not noticeably depend on duration of immersion: with 1-30 sec. at 720° C., the thickness of Al is 0.03-0.04 mm. and of Al_3Fe 0.008-0.03 mm.; at 820° C. and 10-120 sec., 0.02-0.04 mm. Al and 0.08-0.15 mm. Al_3Fe. Practical suggestions for application of the process are included. Ha (8e)

8 **Present Status of Galvanizing Technique and of Galvanizing as Rust Protection (Der gegenwärtige Stand der Verzinkungstechnik und der Verzinkung als Rostschutz).** M. FORSTNER. *Oberflächentechnik*, Vol. 11, Mar. 6, 1934, pages 51-53; Mar. 20, 1934, pages 65-67; Apr. 3, 1934, pages 75-79; Apr. 17, 1934, pages 89-92. Importance of galvanizing and the world consumption of Zn for this use are pointed out. Industrial galvanizing methods and the various galvanized products are discussed. Principal methods are hot and electrogalvanizing, Zn spraying and sherardizing are less frequently used. The question of preference of hot galvanizing or electrolytic galvanizing is still an open one; for castings and for cast pipes the electrolytic method is more advantageous; this should be applied also in all cases of steel when the temperature of hot-galvanizing might be detrimental to the physical properties. The requirements for a good Zn coating
9 are discussed; of Zn layers of the same thickness produced by the 4 processes named the loongest time is required for dissolving the one produced electrolytically, whereas a comparable hot galvanized coating dissolves in less than half the time. Methods for testing Zn coatings are described and bases of comparison accurately defined. Health hazards in galvanizing plants and the economy of processes dependent on operating conditions are discussed. Bibliographic references are given for each section in the treatment of the subject. Ha (8e)

Galvanizing Malleable Castings. GRAFTON M. THRASHER. *Foundry*, Vol. 62, Jan. 1934, pages 19, 49; Feb. 1934, pages 19-20, 60. Before being galvanized, the annealed castings are cleaned by tumbling, sand blasting and/or pickling. After tumbling or sand blasting all depressions and surface irregularities
10 should be examined for sand and scale. Pickling in hot dilute H_2SO_4, as a separate operation, is dispensed with in steel works galvanizing. Usual procedure is a combination of pickle and flux dip. Largest proportion of fitting is galvanized by the basket method which is described in detail. Metal should be at proper temperature before dipping in the zinc, this is about 870° F., + or —10°; flux must be prepared upon its surface. Galvanizing costs are given. VSP (8e)

Zinc for Steel Protection. HERBERT R. SIMONDS. *Iron Age*, Vol. 132, Nov. 16, 1933, pages 13, 56. Mainly a discussion of the use of Zn for coating steel products, especially by electroplating. Suggestions for obtaining satisfactory coatings are included. VSP (8e)

Polished Surfaces Are Liquid. *Machine Design*, Vol. 6, Apr. 1934, page 24. Refers to a discovery of G. I. Finch and co-workers that a polished metal surface is liquid. The London experimenters bombarded polished Cu with particles of Zn emitted from a Zn wire rapidly heated in vacuo. By means of electron diffraction it was revealed that the incoming crystals of Zn were dissolved in the liquid layer of the polished Cu. The process has been termed "vacuum plating" and is believed to have commercial possibilities as substitute for electroplating. WH (8e)

Increasing the Mechanical and Chemical Properties of Silverwork, etc. A New Diffusion Process. (Erhöhung der mechanischen und chemischen Widerstandsfähigkeit für silberne Beschläge usw. Ein neues Diffusionsferfahren). *Deutsche Goldschmiedezeitung*, Vol. 37, Mar. 24, 1934, pages 136-137. According to investigations by Assmann (German patent 596,348) mechanical and corrosion properties of Ag can be improved by a diffusion process in which metals less noble than Ag are used. Ag parts are embedded in pulverized metal to be diffused and heated at 600°-960° C. in neutral atmosphere. Heating time and temperature depend on desired thickness of diffusion layer. GN (8e)

Non-Metallic Coatings (8f)

The Significance of the Expansion Relations of Sheet Enamel (Die Aufklärung der Ausdehnungsverhältnisse bei Eisenblechemails). A. DIETZEL & K. MEUERES. *Sprechsaal für Keramik, Glas, Email*, Vol. 66, Nov. 2, 1933, pages 746-752. Since Mayer-Havas investigations, the enameling industry commonly adheres to the rule that the coefficient of expansion (between 0° and 100° C.) of ground enamel should be $245\text{-}290 \times 10^{-7}$ and that of cover enamel $320\text{-}340 \times 10^{-7}$ to make them fitting to Fe sheet possessing an expansion coefficient of $380\text{-}420 \times 10^{-7}$. A clear explanation for the very low coefficient of expansion of the ground enamel and the fact that an increase of this coefficient to $320\text{-}330 \times 10^{-7}$ results in the formation of hair cracks has not been advanced. In former investigations the coefficient of expansion of the prepared but unburnt enamel or that of the fritted enamel had been used in studying the conditions of expansion but not that of the actually burnt enamel. Authors expansion measurements on Fe oxide bearing enamels that had been burnt (range of measurement between 0° C. and softening point) show that the coefficient of expansion of the ground enamel near the sheet is but slightly less than this one and decreases towards that of the cover enamel to approach gradually an essentially lower value of the cover enamel. GN (8f)

Making Enameled Steel Tubs for Washing Machines. E. F. ROSS. *Steel*, Vol. 94, Jan. 22, 1934, pages 23-25, 32. Describes practice and equipment of Youngstown Pressed Steel Co., Warren, O. Tubs are produced in an electrically operated hydraulic press in a single draw from No. 18-gage deep-drawing stock. Steam-heated chamber is used for drying tubs after cleaning and pickling. Ground and cover coats are dried in a gas-fired oven and baked in a horseshoe-type electric furnace having capacity of 200 tubs per hr. MS (8f)

Asphaltum and Bituminous Lacquers (Asphalt und Bitumenlacke). H. RABATE. *Farben Zeitung*, Vol. 38, Dec. 30, 1933, page 1785. **(Utilizations industrielles diverses des produits asphaltiques et assimilés).** H. RABATE. *Peintures, Pigments, Vernis*, Vol. 10, Oct. 1933, pages 187-194. Compilation of recipes for bituminous coatings for insuring corrosion resistance and electric insulation respectively of ferrous and non-ferrous materials. EF (8f)

A. P. I. Pipe Coating Tests: Progress Reports to the American Petroleum Institute Committee on Corrosion of Oil Field Equipment. Progress Report No. III A—Second Inspection of Pipe Coating Tests on Operating Lines, B—Initial Inspection of Short Coated Specimens. GORDON N. SCOTT. *Proceedings American Petroleum Institute*, Vol. 13(IV), 1932, pages 114-130. The A. P. I. in cooperation with the Bureau of Standards and manufacturers of coating materials instituted a series of field tests of pipe coatings under actual operating conditions. In 1930, 15 sites were selected in 8 states, and 19 different protective coatings, varying in composition, structure, and thickness, were supplied to working lines. In 1931 test methods, which largely eliminated personal judgment and opinion, were applied to the first series of inspections made on part of the coatings. Part A of this report gives details of the second series of inspections. Three more inspections are planned. Part B is concerned with the first inspection of 46 coatings applied to 2-ft. sections of 3-in. pipe. Two more complete sets of specimens, in each of the 15 sites, are yet to be removed. Complete data are given but interpretation of the relative merits of coatings or groups of coatings is left for a later paper. VVK (8f)

Linings for Cast Iron Pipe. D. B. STOKES & H. G. REDDICK. *Journal American Water Works Association*, Vol. 24, Oct. 1932, pages 1582-1589. Problems encountered in lining pipe with cement, bitumastic, pitch, asphalt and vitreous enamel are discussed. A map of the U. S. showing regions of tuberculation of water pipes, prepared from the answers to a questionnaire sent out by the Sectional Committee on Specifications for Cast Iron Pipe, is also given. VVK (8f)

Field Application by Machine of Hot Bituminous Coatings. WM. THOMPSON SMITH. *Gas Age-Record*, Vol. 72, Oct. 7, 1933, pages 339-342, 346. The Gardiner pipe-coating machine is described and field test data given. It is designed for applying hot bituminous coatings in the field in such a way as to eliminate "holidays" and pinholes. With an operating gang of 16, speeds indicating potential capacity well in excess of 9 miles per 8-hour day were attained. Waste of material was about 10% compared with 25 to 50% for the usual sling gang. VVK (8f)

Some Modern Methods of Coating and Lining Pipe. LINDEN STUART. *Journal American Water Works Association*, Vol. 25, Oct. 1933, pages 1431-1438. Description of lining cast iron and steel pipe with bitumastic enamel and of coating the pipe with bitumastic enamel, followed by reinforced cement with a fabric wrapper. Tests on new and on 2-year old lines gave a value of from 144 to 167 for coefficient "C" in the Hazen & Williams formula. VVK (8f)

Economy of Rust-Protective Paints (Wirtschaftlichkeit der Rostchutzfarben). H. HEBBERLING. *Oberflächentechnik*, Vol. 11, May 1, 1934, pages 99-100. Economy of a coat of rust protective paint refers to its total life and includes the cost of production and maintenance plus material and labor. No general formula for its derivation can be given, it is an individual quantity. Weather tests, adhesiveness, swelling and water absorption tests are briefly discussed. 6 references. Ha (8f)

Paints for Aluminum and Its Alloys. M. H. RABATE. *Synthetic & Allied Finishes*, Vol. 4, Oct. 1933, pages 219-222; *Farbenzeitung*, Vol. 38, Dec. 2, 1933, page 1688. See "Paint and Varnish Coatings on Aluminum and its Alloys," *Metals & Alloys*, Vol. 5, May, 1934, page MA 207. EF (8f)

Protective Coatings for Metals on Rubber or Bitumen Basis. *Synthetic & Applied Finishes*, Vol. 5, May 1934, pages 32-33. Chlorinated rubber pigmented with Al powder has been advanced as a protective material for Al and Mg or their alloys. A mixture of tricresyl phosphate and butyl stearate is recommended for plasticization and for the solvent a mixture of tuluol and xylol. The all-important price factor inevitably leads to the adoption of rubber, bitumen, linseed oil and other cheaper natural products for coating work on a large scale. An American proposal is a mixture of rubbers in varying stages of vulcanization, followed by sheet rubber, all finished by complete vulcanization. The following material is suggested to be mixed with 3 times its weight of gasoline and applied to the clean metal surface: 100 parts rubber, 150 ZnO, 25 C black, 5 S, 0.5 Co-stearate and 0.5 organic accelerator. A typical formula for a cheap anti-corrosive coating for cables is quoted: 55 parts paraffin-free oxidized bitumen (Mexican petroleum) are melted with 20 parts of vaseline mixture (containing 40% proto-paraffin and 50% viscous mineral oil) and 25 parts finely fibrous asbestos. EF (8f)

The Protection of Steel Work by Paint Films. S. C. BRITTON. *Synthetic & Applied Finishes*, Vol. 4, Mar. 1934, pages 258-259. Success in protective painting depends as much on chemical inhibition of corrosion as on mechanical exclusion of corrosive influences. Few paints are entirely water-tight and unless the inner coat has some inhibiting influence, rust may form on exposure. The best combination is an inhibitive pigment like red lead in primer coat, with mechanically superior paint in the outer coat. The fact that red lead protects chemically and Fe oxide mechanically is indicated by experiments on thinning. The protective value of Fe oxide decreases with thinning, whereas that of red lead remains almost unimpaired. Surface preparation is important. Best results are obtained when nothing is included between paint and metal. EF (8f)

Protecting Holders against Corrosion. *Gas Engineer*, Vol. 59, Feb. 1934, pages 83-85. Summary of an inquiry on non-drying oils and paints for protecting gas holders by the Gas Holder Maintenance Sub-Committee of the Pacific Coast Gas Association. The corrosion is due to the action of H_2O, O and CO_2. It has been definitely proved that any neutral oil, low in S, gives satisfactory protection against rusting and pitting. For the lifts of water-sealed holders, an oil should be selected which is not affected by sunlight or washed off by rain. Non-drying oil for holder protection is an improvement over former painting method. Instructions on selection and application are furnished. WH (8f)

Aluminum Paint for Outdoor and Interior Use (Aluminumanstrich für Aussen und Innen). R. SCHWARZ. *Farbe & Lack*, Sept. 13, 1933, pages 437-438; Sept. 20, 1933, pages 449-450; Sept. 30, 1933, page 463. Discusses: German invention, American contributions, Al film at various atmospheric temperatures, metallic additions, coatings on wet carriers, alkaline limit for casein solutions, outdoor stability, elasticity, rust protection, Al paints as primers, problem of binding agent, reduction of drying by Al, oil binder for wood, elasticity and protection against moisture, stability on concrete and lime, significance as protection for Fe, cellulose lacquers as binding agent, insulation power. EF (8f)

Protective Rubber Coverings for Propeller Shafts. Y. TAYI. *Far Eastern Review*, Vol. 24, Oct. 1933, pages 477-479. The advantages and shortcomings of brass sleeves, oil immersion stern tubing, cloth or rope winding, protective painting, fescolizing process and electrolysis eliminators are discussed in detail. Vulcanized rubber covering process widely used in Japanese shipyards is considered at length. Basic material is special sheet rubber prepared from pale crepe rubber or smoked rubber sheets to which are added suitable amounts of S, coloring material, agelite or other anti-aging compounds and other chemicals which furnish the required strength, elasticity and anti-fouling property. Various stages in preparation are: removal of grease by heating shaft by steam in cylindrical vessels at 258° F. and 20 lbs./in.^{2}, removal of rust by emery cloth, painting with thick mixture of ebonite in benzene, drying for about 1 hr., stretching 1 mm. rubber sheet over half of shaft longitudinally, removal of air bubbles by hand rollers, covering of the remaining surface of the shaft, and addition of 3 further layers. Total thickness about 4 mm. After tightly binding by wet cotton tape of 5 in. width, canvas tape and steel wire, it is heated for 2 hrs. at 20 lbs./in.^{2} and 7 hrs. at 50-60 lbs./in.^{2}. Four additional layers are prepared in the same fashion. Final total thickness = 8 mm. Final hardness = 87 by Shore's durometer. Damaged rubber covering can be easily patched. Savings of 21% in cost and 98% in weight were attained in comparison with brass sleeves. WH (8f)

TESTING (9)

Inspection & Defects, including X-Ray Inspection (9a)

C. S. BARRETT, SECTION EDITOR

Material Testing in Mining (Materialprüfung im Bergbau). E. SCHLOBACH & F. BUSSEN. *Glückauf*, Vol. 70, Apr. 1934, pages 346-351. The importance of testing all materials used in mining operations and the economical advantages derived from it are pointed out and mechanical, physical, metallographical and technological tests briefly discussed. A layout of a testing shop and its equipment is given. Ha (9a)

Blistering of Aluminum. HANS DIERGARTEN. *Metal Progress*, Vol. 24, Oct. 1933, pages 53-54. Experiments with Al alloys (4.10% Cu, 0.60% Mg, 0.30% Si, 0.40% Mn, 0.30% Fe) indicate that blisters result from the formation of gaseous compounds of high volume by reaction of impurities in the metal with gases of the annealing atmosphere. Parts annealed in argon and vacuum show no blisters. WLC (9a)

Prevention of Flakes in Alloy Steels. H. H. ASHDOWN. *Metal Progress*, Vol. 24, Nov. 1933, pages 13-17, 62. Flakes in alloy steel forgings are said to be due to volume changes in cooling from forging. Practice of equalizing temperature in annealing furnace at 1600° F. and cooling slowly therefrom in furnace is recommended for forgings finished in one heat. Forgings requiring more than one heat when ready for turning around the finished end was heat treated as a finished forging in a furnace with taper heat during which the unforged end was heated to 1100-1200° before placed in the forge furnace. WLC (9a)

Flakes in Forging Steels. FREDERIÇO GIOLITTI. *Metal Progress*, Vol. 25, Feb. 1934, pages 38-39. Discussing "Flakes in Alloy Steels," Ashdown, *Metal Progress*, Vol. 24, Nov. 1933, pages 13-17, 62, the writer contends that such defects are almost never encountered in clean steel. Equal transverse and longitudinal tensile test results are considered evidence of cleanliness. It is contended that flakes are layers of impurities causing a plane of weakness which becomes evident upon application of strain in the tensile test. WLC (9a)

Flaky Structure in Special Treated Steels (Le cause della fratura a squame negli acciai speciali trattati). F. GIOLITTI. *La Metallurgia Italiana*, Vol. 26, Mar. 1934, pages 163-171. Flaking is caused by defects arising during the processes of fusion, refining, or pouring of steel, rather than in the subsequent heat treatment. The trouble may be corrected in a steel which has been properly purified and well deoxidized, by appropriate heat treatment, but it cannot be corrected in impure and poorly deoxidized steels. Giolitti specificially does not limit the probable cause of this trouble to *non-metallic* inclusions in the steel, as interpreted by Ashdown (*Metal Progress*, Vol. 24, Nov. 1933, pages 13-17, and 62) but to any impurity. AWC (9a)

More Comments about Flakes in Big Forgings. W. P. BENTER, EDOUARD HOUDREMONT & C. E. MARGERUM. *Metal Progress*, Vol. 25, May 1934, pages 36-40. Discussion of "Flakes in Alloy Steels," H. H. Ashdown, *Metal Progress*, Vol. 24, Nov. 1933, pages 13-17, 62, and comment of F. Giolitti on same subject, Vol. 25, Feb. 1934, pages 38-39. Benter believes "flakes" occur with high density and low critical range preventing the dissipation of strains which appear after the steel has cooled and lost its plasticity. Houdremont is in definite agreement with Ashdown that flakes are actual cracks and no heat treatment can cure them. Margerum finds flakes associated with basic electric steel, originating at a time after a forging is worked and before it is cold. Their presence may be detected by a number of methods. Flakes have occurred in steels of other manufacture but much less frequently and basic steels have been consistently produced by some melters which do not show flakes. Susceptibility to flaking appears to bear a relation to melting and casting practice though the ruptures occur from local stresses in the cooling of the forging. WLC (9a)

Fillet-Weld Examinations by X-Rays (Röentgentechnische Kehlnahtuntersuchungen). W. GRIMM & F. WULFF. *Autogene Metallbearbeitung*, Vol. 27, Apr. 1, 1934, pages 101-104. The technique of making X-ray investigations of fillet welds is explained; films sensitized on both sides are advisable, and special cameras for fillet-weld exposures are described. An exact examination requires at least 2 exposures in different positions. Examples are given. Ha (9a)

Practical Procedure for Gamma-Ray Testing. GILBERT E. DOAN. *Metal Progress*, Vol. 25, May 1934, pages 22-26. The simplicity of equipment and the thicker sections of metal which can be explored with gamma-rays compared with X-rays are discussed and data are given on relation between exposure and thickness. The economics of the use of radium emanation for examination of metals is discussed. WLC (9a)

Absorption of Hard Gamma Rays (Sur l'absorption des rayons γ pénétrants). W. GENTNER. *Journal de physique et le radium*, Vol. 5, Feb. 1934, pages 49-53. The absorption of gamma rays of various wave lengths has been experimentally determined on Pb with the following results:

Average wave length:	4.7	5.9	6.6	7.9	9.3	A.U.
Absorption coefficient μ_{Pb}cm.$^{-1}$	.47	.50	.545	.57	.65	

EF (9a)

A Decade of Applied X-Ray Research. GEO. L. CLARK. *Journal Society Chemical Industry*, Vol. 52, Apr. 14, 1933, pages 317-325; Apr. 21, 1933, pages 336-346. Review of many X-ray applications, including illustrations, to defects in steel and castings, structure of alloys, mechanism of corrosion, rolling of steel, fatigue phenomena, annealing of sheet metals, mineralogy, paraffin waxes, cellulose, protein fibres, etc. VVK (9a)

Physical & Mechanical Testing (9b)

W. A. TUCKER, SECTION EDITOR

Suitability of the Folding Test for Testing of Welded Joints (Eignung des Faltversuchs zur Prüfung von Schweissverbindungen). G. FIEK & A. MATTING. *Autogene Metallbearbeitung*, Vol. 27, Apr. 15, 1934, pages 115-121. If the folding test is to be used for inhomogeneous material as a weld in fact constitutes, the following factors must be strictly taken into account: 1. diam. of bend, 2. strength of the material, 3. welding method, 4. dimensions of specimens, 5. arrangement of specimens (convention of observation), 6. velocity of bending. The tests were made on the (German) standard structural steels St 34, an unannealed open-hearth steel, St 37, an unannealed Thomas steel, St 42, an unannealed open-hearth steel with about 50% more C, and St 52, an annealed open-hearth steel; exact compositions for the tested thicknesses of 5, 10, and 18 mm. are given, as also the composition of the 6 kinds of welding rods used. The results show that the determination of the bending constant of Tetmajer (=50 × thickness/bending radius) seems to be of not great use because of the difficulties in measuring accurately the bending radius and in particular of dislocation of the neutral fibre which gives only little exact values for greater deformation. It seems questionable if the bending constant is at all suitable for judging a welded joint. Great errors can be committed in determining the elongation values (both in center and total) as the measurement depends too much on the personal factor because of the smallness, mostly fractions of a mm. The general conclusion is not to use the folding test as a scientific means but it is sufficient for the technological determination of the properties of a weld. Suggestions for certain ratios of bending diam. and thickness of material are made. See also "Testing Methods for Welds" *Metals & Alloys*, Vol. 5, May 1934, page MA 210. Ha (9b)

Study of Stress Impact by Photo-Elasticity. (3rd Report). Zirô Tuzi & Masataka Nisida. *Bulletin Institute of Physical & Chemical Research, Tokyo*, Vol. 13, Mar. 1934, pages 148-162. In Japanese; *Scientific Papers & Abstracts of the Institute of Physical & Chemical Research*, Vol. 23, Mar. 1934, pages 14-15. In English. In the case of lateral beam impacts, the duration of the impact, and the frequencies of the natural oscillation of the beam after the impact were calculated theoretically and the experimental values were found to coincide rather closely. Circular rings of phonolite on an anvil were struck by falling weights and the stress variations photographed by means of photo-elasticity using a red light source and exposures of about 1/50,000 sec. The maximum stresses produced at the horizontal section in the ring were about 80% of the calculated values and dynamic deflections 80-90% of the theoretical values. WH (9b)

Testing Methods for Welds (Prüfverfahren für Schweissungen). G. Fiek. *Die Elektroschweissung*, Vol. 5, Apr. 1934, pages 67-71. Paper before Deutsche Gesellschaft für Elektroschweissung, Jan. 15, 1934. See *Metals & Alloys*, Vol. 5, May 1934, page MA 210. GN (9b)

Effect of Thickness of Metal Sheet on Diamond Pyramid Hardness Test Results. G. A. Hankins & C. W. Aldous. *Sheet Metal Industries*, Vol. 8, Apr. 1933, pages 241-243. See "Minimum Dimensions of Test Samples for Brinell and Diamond Pyramid Hardness Tests," *Metals & Alloys*, Vol. 5, Apr. 1934, page MA 146. AWM (9b)

Notch Impact Test for Mild Steel (Ueber die Kerbschlagprobe bei Schweissstahl). *Technisch Blätter der deutschen Bergwerkszeitung*, Vol. 23, Mar. 26, 1933, page 190. Abstract of paper by E. Schneider in *Mitteilungen aus den Forschungsanstalten des Gutehoffnungshütte-Konzerns*, Vol. 2, Mar. 1933. See *Metals & Alloys*, Vol. 5, May 1934, page MA 209. GN (9b)

On the Elastic Extension of Metal Wires under Longitudinal Stress. Part III. Theoretical. L. C. Tyte. *London, Edinburgh, & Dublin Philosophical Magazine & Journal of Science*, Vol. 17, Mar. 1934, pages 634-651. Stress and total extension of metal wires are related by an exponential function holding good from small loads up to the yield point. The theory is developed in detail; 18 references. Ha (9b)

Studying Structural Stresses with the Aid of the Polariscope. E. W. P. Smith. *Welding Engineer*, Vol. 19, Apr. 1934, pages 17-19. Principle of using polarized light in transparent models for detection of stresses and application of this method to testing of welds is explained. Direction for making specimens for testing are given. Ha (9b)

Determination of Brinell Hardness in Steel (Zur Bestimmung der Brinellhärte von Stahl). A. Hasch. *Montanistische Rundschau*, Vol. 26, May 16, 1934 (Section *Stahlbau-Technik*) page 5. Discusses the various modification of the Brinell test for steel. BHS (9b)

Use of the Araeometer for the Determination of Very Small Differences in Density of Metals (Die Anwendung des Areometers zur Untersuchung sehr kleiner Dichteänderungen der Metalle). A. E. Brüchanov. *Metallwirtschaft*, Vol. 13, Mar. 23, 1934, pages 206-208. The apparatus consists of a closed, hollow glass bulb of about 50 cc. capacity from which the sample, weighing about 50 grams is suspended. The whole is immersed in water and the level at which it floats is indicated on a scale by a pointer attached to the bulb. By this method differences in density between several samples or in the same sample after cold rolling, not absolute density, are measured. The accuracy is .0002 gram. It is important that the surface of the samples be absolutely clean, the water very pure and the temperature constant. Tests made on .05, .41 and .58 C steel indicated a fairly steady decrease in density with cold rolling up to about 35% reduction, a slight increase in density between 35% and 45% cold rolling, and further decrease beyond that. The decrease in density amounted to .0150 with 65% reduction in the .05 C, .0326 with 53.1% reduction in the .41 C, and .0172 with 57.6% reduction in the .58C steel. CEM (9b)

Tensile Testing of Weld Joints (Die Zerreissprüfung von Schweissverbindungen). Czternasty. *Elektroschweissung*, Vol. 5, Mar. 1934, page 56. Short tensile test bar standardized by Preussischer Dampfkessel-Überwachungs- Verein for tensile tests on boiler welds is described. Disadvantages of other types of test bars are pointed out. Numerous tests made with described short bar in recent years proved its suitability for testing weld joints. GN (9b)

Recording Pendulum Sclerometer (Selbstschreibendes Pendelsklerometer). A. Aschubnikoff. *Zeitschrift für Kristallographie*, Vol. 87, Apr. 1934, pages 499-502. The improvements contributed by Kolesnikow, Lawrentjewa, Rebbinder, Kalinowskaja regarding the original sclerometer of Kusnezow are reviewed. The instrument is based on the damping of the oscillations of a pendulum which is resting on the testing material. The author perfected the tester furthermore by an optical recording device. The underlying formulae previously introduced by Aravjskaja and Rehbinder are discussed critically and supplemented. EF (9b)

Hardness Measurements on Binary Alloys of Pb-Sb, Sb-Sn, and Pb-Sn. Nobutoshi Aoki. *Kinzoku no Kenkyu*, Vol. 11, Jan. 1934, pages 1-20. In Japanese The Brinell hardness of 3 binary alloys, Pb-Sb, Sb-Sn and Pb-Sn have been determined and the relations between the hardness and their microstructures and equilibrium diagrams have been investigated. The investigations have been carried out from the following 5 points: (1) Change of hardness with load, (2) change of hardness with loading time, (3) effect of aging at room temperature, (4) effect of annealing at a temperature nearly below the solidification point and (5) change of hardness with composition. The results obtained are as follows:—(1) The hardness gets greater with increasing load. γ (Sn-sides of Pb-Sn and Sn-Sb alloys) and δ phase (Pb-sides of Pb-Sb and Pb-Sn alloys) shows a maximum hardness and then decreases slowly. But α (Sb-sides of Pb-Sb and Sn-Sb alloys) and β phase of Sn-Sb alloy increase the hardness with load until they break. (2) The decrease of hardness with loading time is in the following order; least $\alpha + \beta$ of Sn-Sb alloy and $\alpha + \delta$ of Pb-Sb alloy; great, $\beta + \gamma$ of Sn-Sb alloy; greatest, $\gamma + \delta$ of Pb-Sn alloy. (3) The hardness of $\alpha + \delta$ of Pb-Sb alloy increases by aging and greatest effect was found in Pb-rich (or δ-rich) alloys. Softening by aging was found in $\gamma + \delta$ of Pb-Sn alloys and the greatest effect was found in δ-rich alloys. (4) By annealing the alloys become softer. But when the solubility of another element increases by the annealing, the hardness increases. (5) The hardness changes greatly in a single phase range with increasing solubility of another element. In two phase range the change is not so great. KT (9b)

Relationships of Hardness Numbers. W. E. J. Beeching. *Metal Industry*, London, Vol. 44, Feb. 16, 1934, page 188. See *Metals & Alloys*, Vol. 5, Apr. 1934, page MA 146. Ha (9b)

Some Magneto-Elastic Torsion Experiments (Einige magneto-elastische Torsionsversuche). R. Becker & M. Kornetzki. *Zeitschrift für Physik*, Vol. 88, No. 9/10, 1934, pages 634-646. The experiments show the effect of exterior stresses on spontaneous magnetization. Ha (9b)

Stress Measurements on Springs (Spannungsmessungen an Schraubenfedern). F. Thiersch. *Forschung (Zeitschrift Technische Mechanik und Thermodynamik)*, Vol. 5, Mar./Apr. 1934, pages 53-59. Results of stress measurements verify the fact that the theory of Göhner is a reliable basis for calculating springs. The largest shear stress occurring is decisive for the load sustained. It is pointed out that in most cases the calculation of springs must be based on their fatigue limit. The calculation has to take into consideration the surface condition and the safety factor that is affected by the surface condition. In doing this the result for dynamically loaded springs are by far lower than might be expected from the high static tensile strength. This explains why many springs do not stand the loads they were expected to sustain. GN (9b)

Testing Sheets with the Erichsen Apparatus (Die Blechprüfung mit dem Erichsengerät). G. Sachs. *Metallwirtschaft*, Vol. 13, Feb. 2, 1934, pages 79-81. The Erichsen test, as made with the standard plunger, gives a ductility value comparable to elongation in a tensile test. It has been shown that in many ways the deep drawing properties of sheet metals are more closely related to the reduction of area in a tensile test than to elongation. To obtain a ductility value equivalent to reduction with the Erichsen apparatus a special plunger shaped like the frustum of a cone is used. The first reading is taken when a crack appears in the metal, as in the standard test, which gives a "depth" value similar to elongation. This reading is somewhat lower than that obtained with the standard plunger on the same materials. The test is then continued by forcing the plunger through the opening formed in the sheet until a tear appears in the circumference of the hole. This reading is called "stretch" and is equivalent to reduction of area. The ratio of depth to stretch varies with different metals. The stretch reading for ordinary electrolytic Cu is much lower than for Cu deoxidized with P, while the depth reading is almost the same for both. The depth determinations with the special plunger do not vary with different thicknesses as much as with the standard plunger. It is necessary to change the mirror arrangement for the modified test. CEM (9b)

Fatigue Testing (9c)

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in coöperation with the A.S.T.M. Research Committee on Fatigue of Metals.

Effect of Repeated Torsion on Strength and Damping Properties of Aluminum Alloys (Der Einfluss von Drehschwingungsbeanspruchungen auf die Festigkeit und Dämpfungsfähigkeit von Aluminum-Legierungen). Hans Frankenberg. *Metallwirtschaft*, Vol. 13, Mar. 16, 1934, pages 187-191. See *Metals & Alloys*, Vol. 5, May 1934, page MA 212. CEM (9c)

Endurance Strength of Welded and Cast Structural Parts (Zur Frage der Dauerhaltbarkeit geschweisster und gegossener Konstruktionsteile.) A. Thum & Th. Lipp. *Die Giesserei*, Vol. 21, Feb. 2, 1934, pages 41-49, Feb. 16, 1934, pages 64-71, Mar. 2, 1934, pages 89-95, Mar. 30, 1934, pages 131-141. Very exhaustive tests were made with cast and welded ⊥-pieces to determine the endurance strength. A difference was found in the behavior of large and small pieces in favor of the latter due to the comparatively very extended length of the weld; by proper treatment of the weld the strength of larger pieces can, however, be increased 15%. A very tough material should be used for the electrode. Large castings have a lower endurance strength than the small ones about 2-3 kg./mm.^{2} less, due to the greater wall-thickness; in spite of coarser graphite precipitation a certain surface sensitivity remains, small gas holes and defects at places of high stress must be absolutely avoided. A low β_K-value (ratio of endurance strength to durability) determines the quality of cast iron. Steel castings especially must show cleanest possible surface and sound casting in order to utilize the good properties of this material to the fullest. Methods of testing such pieces are discussed and described, only endurance test should be used for judging quality. (Note by H. F. M.: The claim that endurance test *alone* is to be used for judging quality is very unusual.) Details and individual behavior under different conditions are illustrated in tables, charts and illustrations which must be referred to. 64 references. Ha (9c)

Fatigue Tests of Galvanized Wire Under Pulsating Tensile Stress. S. M. Shelton & W. H. Swanger. *Proceedings American Society Testing Materials*, Vol. 33, Pt. 2, 1933, pages 348-360. The limiting range of pulsating tensile stress was determined at various mean tensile stresses on a heat-treated galvanized steel wire and on cold-drawn galvanized bridge wire of approximately the same carbon content and tensile strength. Determinations were made on a Haigh alternating-stress testing machine set up to subject the specimens to tensile stresses only. The specimens were unaltered sections of commercially galvanized wire 0.192 in. in diameter. A very ingenious gripping device for wire is described in detail. The limiting range of pulsating stress or "tensile fatigue limit" was determined at mean stresses increasing by increments of approximately 20,000 lbs./in.^{2} between 50,000 and 150,000 lbs./in.^{2}. The results for each mean stress were plotted on S-N diagrams and the limiting ranges for the various mean stresses were plotted on a single diagram for each type of wire. The results are also tabulated. The results obtained show definitely that the magnitude of the range of stress, rather than the value of the maximum stress, determined the fatigue limits of the materials. VVK (9c)

The Decrease in Alternating Torsional and Bending Fatigue Strength by Corrosion and its Increase by Surface Hardening (Die Erniedrigung der Schwingungsfestigkeit durch Korrosion und ihre Erhöhung durch Oberflächendrucken). O. Föppl, O. Behrens & Th. Dusold. *Zeitschrift für Metallkunde*, Vol. 25, Nov. 1933, pages 279-281. Ten materials were studied: medium carbon steel; Ni-steel; Cr-Ni-W-steel; pure Ni; "stainless" steel; nitriding steel; 4 Al alloys as follows: Al with 5.6% Cu, 0.7% Mn; Al with 10% Zn; Al with 10% Zn, 0.5% Cr, 1.8% Si, 1.3% Pb; Al with 0.7% Mn, 0.7% Mg, and 1% Si. The whole gage length of the specimens were immersed in the corroding medium, which was water running at a rate of 10 cm^3 per sec.; the course of the corrosion was observed through the glass containing tube. The fatigue process was run by stressing for 2 million cycles, then raising the load 10%, stressing again in similar steps until fracture occurred. The fatigue limit was thus determined on the original materials in air and in water, then on samples which had been surface hardened by cold-work in air and in water, and finally on materials electroplated with Zn. The data are summarized graphically. The fatigue strength is generally raised by surface work-hardening, and decreased by corrosion. The values obtained in air on the original materials may be attained in water on materials which had been surface hardened. Similar data are given on bending tests; the influence of corrosion is greater with this test. Surface work-hardening is observed in some cases to increase the corrosion fatigue strength to values five times that of the unhardened samples. It is concluded that the effect of surface work-hardening on impeding corrosion fatigue is one of rendering the surface density greater and thus impeding the penetration of water, rather than one of internal strain. RFM (9c)

Aluminum Conductor Vibration. J. L. Eve. *Electrical Review*, Vol. 114, Apr. 27, 1934, pages 595-596. Abstract of paper read before the Overhead Lines Association, Apr. 18, 1934. Includes discussion. Fracture of strands of steel-cored Al overhead-line conductors is due to vibrational fatigue. Most of the fatigue failures in Eng. in last 2 years have occurred on a particular size, *viz.*, 0.15 sq. in. Cu equivalent made up of 37/0.102. Vibration is most prevalent when wind velocity is about 5 m./hr. and where transmission line runs across unobstructed country. These fractures have occurred mostly at suspension points. Failure will take place only when there is vibration at a time when the tension in the individual Al strands is above a certain amount. Advocates the advisability of over-stressing the conductor before finally sagging the line. MS (9c)

Fatigue Properties of Structural Steels (Die Dauerfestigkeit der Baustähle). G. Schaper. *Bautechnik*, Vol. 12, Jan. 12, 1934, pages 23-24. Fatigue tests on steels St. 37 and 52 (German standard structural steels) carried on by German State Railway Co. showed the remarkable fact that the initial strength, i.e., the stress which is just still endured at 2,000,000 load cycles changing between zero and a certain upper limit, of steel St. 52 is not much higher than that of steel St. 37. Besides tests on these structural steels similar fatigue tests were made on German and American Ni steels giving the same result, i.e., also the fatigue properties of these steels were not much better than those of steel St. 52. GN (9c)

Spectrography (9e)

Grayson's Micro-Rulings. W. STONE. *Journal of Scientific Instruments,* Vol. 11, Jan. 1934, pages 1-6. Details of the technique developed for producing micro-rulings on realgar films are given and his machine described. This paper comment on some of the difficulties encountered in the ruling. Some historical notes are included. RAW (9e)

Spectrographic Detection of Contaminations in Copper (Dosage de quelques constituants secondaires dans le cuivre par voie spectrographique). RAIMOND BRECKPOT. *Annales de Bruxelle,* Sect. B, Vol. 53, No. 3/4, pages 219-247; *Physikalische Berichte,* Vol. 15, May 1, 1934, page 725. The presence of small quantities of contaminations in Cu has been studied spectroscopically. Among the Pb lines, 19 can be utilized down to 1% Pb, 10 down to 0.1% and 3-9 down to 0.001% Pb. The most sensitive line 2833 should be useful down to 0.001% Pb, but no Cu sufficiently pure could be secured to prove this definitely. In a similar manner 0.0001% Ag can be determined with the aid of line 3382.88. Concerning Sb only the lines 2311.5, 2528.54 and 2598.07 are safe to use down to 0.01% Sb. Below this concentration identification down to 0.0001% is only possible if the coincidences with Si and Fe lines are intelligently traced. If the Fe spectrum with its abundance of lines is absent, Bi can be traced by the line 3067.73 down to 0.001%. A Bi content of 1% furnishes 15 lines suitable for indentification, while 1% As yields 30 suitable lines. This number drops to 5 and 2 lines in the case of respectively 0.1% and 0.01% As. A further line 2288.14 is still more sensitive but unfortunately coincides with a highly sensitive Cd line. WH (9e)

Metallurgical Spectrum Analysis. WELTON J. CROOK. *Transactions American Society for Steel Treating,* Vol. 21, Aug. 1933, pages 708-732. The construction and use of 21-ft. focal length grating spectrograph for metallurgical analysis is described. Method of enlarging the image from the spectrum film so that 1 A.U. = 5 mm. obviates the tedious method of use of micro comparator for reading. WLC (9e)

METALLOGRAPHY (10)

J. S. MARSH, SECTION EDITOR

The Crystalline State. Edited by W. H. BRAGG & W. L. BRAGG. **Vol. I. A General Survey.** W. L. BRAGG. MacMillan Company, New York, 1934. Cloth, 6 x 9¼ inches, 352 pages. Price $5.50.

The first Laue photograph of X-ray diffraction by a crystal was obtained in 1912. Within three years X-RAYS AND CRYSTAL STRUCTURE by Bragg and Bragg appeared. The effect of that book in paving the way for the investigation of crystal structure and for the writing of other books cannot be overestimated.

X-ray crystal structure has now reached its majority, the age of discretion. It is quite fitting that at this time the Braggs, who have continued to be extraordinarily active in this field, should undertake a complete and critical summary of it. With the help of numerous collaborators they have planned to cover the subject in three volumes. Volumes II and III, as yet unpublished, will deal in detail with theory and methods, and with the results of structure analysis. It is to be regretted that the projected fourth volume, to contain an atlas of space-groups and tables, was abandoned on the grounds, which many will consider inadequate, that such material is available in the International Critical Tables.

Volume I, now at hand, gives a general picture of the crystalline state and the methods by which it can be investigated. It is intended to serve as an introduction to the later volumes. It is complete in itself, containing sufficient to provide a good foundation for one unfamiliar with the subject. The specialist will admire it for its breadth of view and its clarity of statement. He will find many things taken from the earlier Bragg books, but that the book as a whole is new, not a revision. The set, of which this book is a part, will probably become the standard reference in English to X-ray crystal structure. H. W. Russell (10)—B—

New Phenomena of Change of Resistance of Bismuth Monocrystals in Magnetic Fields. I. An Electric Method for the Analysis of Crystal Structure (Ueber neue Erscheinungen bei der Widerstandänderung von Wismuteinkristallen in Magnetfeldern. I. Eine elektrische Methode zur Kristallstrukturanalyse). O. STIERSTADT. *Zeitschrift für Physik*, Vol. 80, Feb. 16, 1933, pages 636-665. Changes of electric conductivity of Bi in a magnetic field were investigated for all orientations of the crystal with respect to the magnetic field. Diagrams show the influences of the crystal faces which are important for the crystal structure. Curve showing change of magnetic resistance is different from that of electric conductivity. This is most pronounced in the direction perpendicular to the main axis, at which the electric resistance does not change at all with the crystalline structure, whereas the magnetic resistance varies with the structure. It is shown how this method may be used for analysis of crystals. 15 references. Ha (10)

Crystal Structure and Electric Properties. II. Lattice Structure and Conductivity of Bi-Monocrystals under Transverse Magnetization (Kristallstruktur und elektrische Eigenschaften. II. Gitterbau und Leitfähigkeit von Bi-Einkristallen bei transversaler Magnetisierung). O. STIERSTADT. *Zeitschrift für Physik*, Vol. 85, Sept. 14, 1933, pages 310-331. Change of magnetic resistance of the Bi-monocrystal was found to depend upon orientation of the crystal axes with respect to the direction of the magnetic field. The method can be used to determine the axes of a crystal without destroying it. Ha (10)

Crystal Structure and Electric Properties. III. Lattice Structure and Conductivity of Bi-Monocrystals under Longitudinal Magnetization (Kristallstruktur und elektrische Eigenschaften. III. Gitterbau und Leitfähigkeit von Bi-Einkristallen bei longitudinaler Magnetisierung). O. STIERSTADT. *Zeitschrift für Physik*, Vol. 85, Oct. 14, 1933, pages 697-707. The structure of a metallic crystal lattice can be determined accurately by the electric conductivity in a longitudinal magnetic field, just as in a transverse field. Ha (10)

Constitutional Diagram of Germanium-Copper (Das Zustandsdiagram Germanium-Kupfer.) ROBERT SCHWARZ & GERTRUDE ELSTNER. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 217, Apr. 7, 1934, pages 289-297. The complete Ge-Cu diagram was developed and the properties of the alloys were investigated. Cu dissolves up to 10% Ge with formation of α-solid solution; at 828° C., a peritectic transformation takes place to form β-solid solution with about 14 atomic % Ge. The liquidus line of β-solid solution extends to 3Cu:1Ge. The only compound found was Cu_3Ge; it forms at 700° C. from the saturated, about 24.5% Ge-containing γ-solutions and melt. γ-solid solutions are segregated primarily from melts with 75-70 atomic % Ge. The eutectic lies at 35% Ge and 65% Cu, and solidifies at 650° C. Cu-Ge alloys have, up to 17% Ge, a pronouncedly golden-yellow color, Cu_3Ge is silver-white with a bluish tint; alloys with more Ge are greyish-white. All alloys are resistant to HCl, up to 25% Ge they are attacked by concentrated HNO_3, beyond this percentage only by aqua regia. Cold concentrated H_2SO_4 does not attack even Ge-poor alloys; boiling acid disintegrates them slowly. The hardness of Cu is considerably increased by Ge, also the brittleness which becomes, at the composition of Cu_3Ge, so strong that a sample can be easily powdered in a mortar. Ha (10)

Some Micrographic Aspects of Ordinary Annealed Carbon Steels. Conditions under which They are Obtained and Modified (Quelques Aspects Micrographiques d'un Acier Ordinaire dur au Carbone Recuit. Conditions de Formation des Divers Aspects et Conditions de Modification). J. SEIGLE. *Chimie et Industrie*, Vol. 30, Dec. 1933, pages 1282-1289. Micrographic study was made of the various structures present in ordinary annealed carbon steels under heat-treating conditions which were maintained accurately at critical temperature because operations were carried out with the aid of a dilatometer on which changes can be noted and regulated. The dilatometer indicates all micrographic changes and thereby eliminates any misinterpretation which might be made of the formations occurring when pearlite changes from a solid solution and vice versa. A new theory is established. It appears that it may present a very good interpretation of certain accepted facts. The conclusions follow: (1) When heated, a small quantity of pearlite continues to exist up to the end of the dilatometric anomaly, except when heated for a long time or during prolonged hardening after the first heat. The second heating in that case produces a coalesced structure. (2) When cooled the pearlite is formed at the end of the dilatometric anomaly. (3) The pearlite in a hard steel may have a low average amount of inferior carbon (0.85-0.90%). The steel tested retained at all time the peculiarities of an annealed steel. MAB (10)

The Composition and Critical Temperature of Pearlite Containing One Per Cent Silicon. A. E. SCHOWALTER & W. W. DELAMMATTER WITH H. A. SCHWARTZ. *Transactions American Society for Metals*, Vol. 22, Feb. 1934, pages 120-138. Steels containing 0.14-0.76% C were cooled through range of rates 5-100° C. per min. Value was determined for the C content which would be 100% pearlitic at 0.92%. Conclusions from data obtained are: Si does not lower the C content of eutectoid, but appears to raise it slightly with 1% Si; 1% Si raises the A_1 point between 20 and 40° C. WLC (10)

X-ray Apparatus for Fine-structure Investigations (Geräte für röntgenographische Feinstrukturuntersuchung). W. E. SCHMID. *Zeitschrift für physikalische Chemie*, Abt. B, Vol. 23, Dec. 1933, pages 347-357. The latest type of X-ray camera for Debey-Scherrer-Hull photographs developed by the Siemens & Halske Company is described in detail. Four cameras can be exposed simultaneously. The apparatus operates at 90 kvolts and 30 mamps. and exposure times between 1 and 30 min. are realized. Test data are presented. Adjusting of the camera is greatly facilitated by mounting it on a ball joint which comprises the range of the primary radiation. EF (10)

Mounting of Small Metallographic Specimens and Metal Powders in Bakelite. H. M. SCHLEICHER & J. L. EVERHART. *Metals & Alloys*, Vol. 5, Mar. 1934, pages 59-60. The use of liquid resinoid materials to replace low-melting alloys for mounting metallographic specimens is described. Advantages cited for the material are: resistance to usual etchants, hardness, and failure to smear. The specimens are simple to prepare and use of liquid resinoid materials appears preferable to the pressure method using a powdered material, especially with very soft materials. Hardening is obtained by curing at 85-130° C. WLC (10)

Novel X-ray Goniometer and Comment on the Paper of E. Sauter "A Simple Universal Camera for X-ray Crystal Structure Analysis" (Über ein neues Röntgengoniometer. Gleichzeitig Bemerkung zu der Arbeit von E. Sauter: "Eine einfache Universalkamera für Röntgenkristallstrukturanalysen"). E. SCHIEBOLD. *Zeitschrift für Kristallographie*, Vol. 86, Nov. 1933, pages 370-383. Fully describes and illustrates a universal camera developed by Schiebold and his co-workers. The recently described camera of Sauter (*Zeitschrift für Kristallographie*, Vol. 84, Feb. 1933, pages 461-467, Vol. 85, Mar. 1933, pages 156-159.) is based on the same principle. The evaluation of the diagrams is fully taken up. The equipment can also be employed for crystal powder. EF (10)

X-ray Determination of the Thermal Expansion of Silver (Dilatation thermique de l'argent mesurée aux rayons X). H. SAÍNI. *Helvetia Physica Acta*, Vol. 6, No. 8, 1933, pages 597-607. Expansion coefficient of Ag between 20° and 400°C. was determined by the X-ray method of Seemann-Bohlin. The cylinder of the spectograph was split into unequal parts, one of which carries the sample and the heating device, while the other one contains the film. The sources of error are discussed at length. Cu and Ni K α radiation yielded an edge length of the unit cube of 4.0774 ± 0.00015 A.U. at 18°C, and 4.0992 ± 0.00015 A.U. at 300°C. The thermal expansion coefficient derived therefrom is $\alpha = 19 \pm 0.2 \times 10^{-6}$. EF (10)

A. S. M. Meeting on Grain Size Attracts Wide Attention. *Steel*, Vol. 94, Apr. 30, 1934, pages 44, 46. Report, with abstracts of papers presented, of the tri-chapter meeting of the Cincinnati, Dayton, and Columbus chapters of the American Society of Metals in Columbus, O., Apr. 24, 1934. MS (10)

Freezing Temperatures of Standard Tin Soldering Alloys (Die Erstarrungstemperaturen der genormten Lötzinn-Legierungen). O. BAUER & M. HANSEN. *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, page 39. The freezing points (liquidus temperatures) of Sn-soldering alloys were determined as follows: 90.1% Sn, 1.0% Sb, the rest Pb,—219°; 60.05% Sn, 3.20% Sb, the rest Pb,—185°; 50.08% Sn, 3.27% Sb, the rest Pb,—200°; 40.06% Sn, 2.61% Sb, the rest Pb,—223°; 33.05% Sn, 2.15% Sb, the rest Pb,—242°; 30.08% Sn, 1.96% Sb, the rest Pb,—249°. The temperature of simultaneous deposition of the Pb-rich solid solution and the SnSb solid solution (β) was determined for the last alloy to be 194°; in this alloy the reaction β + melt $\longrightarrow$ Sn-rich solid solution + Pb-rich solid solution was determined as 184°. The temperature of the Pb-Sn eutectic was found to be 181-184°. RFM (10)

Location of Alpha Phase in 18-8 by Magnetic Powders. GEORGE W. AKIMOV. *Metal Progress*, Vol. 25, Mar. 1934, pages 42-43. Describes the method of studying the location of ferrite areas in cold-worked austenitic steel by the precipitation upon a polished surface of a magnetic powder (FeO) carried in suspension in alcohol. WLC (10)

Studies on the System Aluminum-barium (Untersuchungen über das System Aluminium-Barium). E. ALBERTI. *Zeitschrift für Metallkunde*, Vol. 26, Jan. 1934, pages 6-9. Al-Ba alloys were prepared by reacting BaO with Al under a flux of $BaCl_2$. The resultant alloy was cast free of flux. Thirty-one alloys were prepared, ranging from 0 to 36.3% Ba. Cooling curves were taken and from these a t-x diagram developed. Within this range the alloys are completely miscible in the liquid state. The addition of Ba lowers the melting point of Al from 659° to 651° at 2% Ba, the eutectic temperature and composition. The liquidus curve rises rapidly with increasing Ba, reaching 1013° at 36.3% Ba. No solid solutions are found within this range. Microscopic observations (ten photomicrographs) were made on alloys up to 50% Ba which confirmed these findings. Crystals of a compound of unknown composition, lying at a Ba composition higher than those of the alloys studied, were observed in alloys with more than 2% Ba. RFM (10)

The Veining of Ferrite (Die Aederung des Ferrits). E. AMMERMANN & H. KORNFELD. *Archiv für das Eisenhüttenwesen*, Vol. 7, Apr. 1934, pages 567-570. Proof is advanced that α-veining is not due primarily to impurities in the iron, particularly O_2, segregated along the veins, as suggested by Northcott. Instead, α-veining is stated to be due mainly to the α-γ transformation, the α-veins being the boundaries of crystallites of similar orientation and vestiges of the grain structure which existed in the γ condition. As proof of this, the following is cited: Veining can be eliminated by recrystallization below A_3. Veining appears in iron originally showing no veining, after heating through the α-γ transformation. Alloy steel with no α-γ transformation shows no veining. Deoxidation, as in H_2, has no effect on veining. The "veining" which is stated to appear in transformationless metals like Cu and Ni is really not the same as α-veining. The "veining" in Cu and Ni can be eliminated by heating in H_2. SE (10)

The Linear Thermal Expansion and Alpha-Gamma Transformation Temperature (A_3 point) of Pure Iron. J. B. AUSTIN & R. H. H. PIERCE, JR. *Transactions American Society for Metals*, Vol. 22, May 1934, pages 447-470. Linear thermal expansion of 10 samples of pure iron was determined from room temperature to 950°C. by means of a vacuum interferometer. True expansion coefficient passes through a maximum 400°-500°C., then a minimum at A_2 point, without abrupt change in length. A_3 temperature appears to be 928°C. Expansion data are in agreement with X-ray evidence. Results indicate that those impurities which have greatest influence upon magnetic properties may or may not shift alpha-gamma transformation. Iron melted in H_2 appears to be contaminated by reduction of crucible material; vacuum melting or sintering in H_2 give better product. WLC (10)

The Mechanism of Crystal Growth. WHEELER P. DAVEY. *Transactions American Society for Steel Treating*, Vol. 21, Nov. 1933, pages 965-1001. The growth of crystals is taken up systematically from experimental evidence of growth from vapor, melt, solution, and solid. The physical conditions accompanying growth are discussed and imperfection is found to be the natural state of the crystal. Following the lines of Zwicky's theory, a picture of the growth of crystals is evolved in which imperfection is inherent and the ordinary properties of materials such as mode of crystallization, tensile strength, segregation and the like, follow as natural corollaries. In discussion, N. A. Ziegler points to agreement of certain magnetic measurements on nearly pure iron as indirectly corroborating theory that crystals are inherently imperfect. R. F. Mehl in discussion suggests that evidence of imperfection of crystals need not explain mosaic structures. 31 references. WLC (10)

The Contribution of X-ray Studies to Metallurgical Progress (Die Auswirkung der Röntgenstrahlenuntersuchung auf die Entwicklung der Metallkunde). U. DEHLINGER. *Archiv für das Eisenhüttenwesen*, Vol. 7, Mar. 1934, pages 523-526. A brief correlated abstract dealing mainly with the light thrown by X-rays on the problems of solubility limits in alloys, deformation, ageing, and recrystallization. 13 references. SE (10)

Contribution to the Explanation of Occurrences in β-Aluminum Bronze (Ein Beitrag zur Deutung der Vorgänge in β-Aluminium-bronze). U. DEHLINGER. *Metallwirtschaft*, Vol. 13, Mar. 23, 1934, pages 205-206. The transformations in β-Al bronze are discussed according to the principles of thermodynamics, especially hysteresis temperature. The "β" phase is compared in its behavior with martensite in steel. CEM (10)

System Copper-Lead (Das System Kupfer-Blei). WILLI CLAUS. *Metallwirtschaft,* Vol. 13, Mar. 30, 1934, pages 226-227. A slightly different constitutional diagram from that previously published is given. The A curve indicating the appearance and disappearance of the second phase during the condensation-dispersion process is the same. The original B line is resolved into a B_c horizontal at 999°C., indicating the appearance of layer formation during condensation, and a B_D horizontal at 1300°, indicating the temperature of the disappearance of layers during the dispersion process. CEM (10)

6

A Metallographic Method for Determining Furnace Temperature Uniformity. E. H. DIX, JR. & A. C. HEATH, JR. *Metals & Alloys,* Vol. 5, Jan. 1934, page 10. Describes the procedure used in determining temperature gradients in a small electric-muffle furnace by the examination of specimens of 6% Si-Al alloy placed at various points in the furnace. The furnace was operated on automatic temperature control using a thermocouple of fixed location. Using temperatures in the vicinity of the eutectic melting point of this alloy, it was possible by metallographic examination of the specimens to get an idea of the temperature variations by the presence or absence of liquation of the eutectic. WLC (10)

7

Burned and Overheated Steels. JOSEPH A. DUMA. *Heat Treating & Forging,* Vol. 20, Apr. 1934, pages 167-169. Summarizes theories of Howe, Stead, and Stansfield, and describes methods of detection. Burned steels can be identified macroscopically, after either an electrolytic or nital etch, by the large voids following the grain contours. To detect overheated steels, specimen is first heated above its critical point, H_2O quenched, rough polished on 1 side, and then made the anode of an electrolytic cell with an Al plate as the cathode. Electrolyte is a 7% HNO_3 solution. A 50 milliamp. current at 10 volts is used. After 10-20 min. immersion, specimen is washed in H_2O, lightly polished with levigated Al_2O_3, and examined microscopically. If it reveals a large grain network, it is overheated. For Si-Mn steels, however, a 4% HF solution in glycerin is used as the electrolyte. $K_2Cr_2O_7$ has also been used successfully as an electrolyte. Burned and overheated structures may be developed also by Stead's cupric reaget. The P segregates show up as nodular masses. MS (10)

8

What Does Sorbite Look Like? CHARLES Y. CLAYTON. *Metal Progress,* Vol. 25, Mar. 1934, pages 43-44. WLC (10)

A New Optical Dilatometer (Ein neues optisches Dilatometer). FR. BOLLENRATH. *Zeitschrift für Metallkunde,* Vol. 25, July 1933, pages 163-165; Vol. 26, Mar. 1934, pages 62-65. The Chevenard dilatometer is modified by the inclusion of two separate couplings between the expanding bar and the reference bar, and the lever, permitting a free compound movement of the lever. This avoids friction during expansion and contraction; a force of 10 to 12 g. suffices to maintain contact in the assembly, in comparison with 150 g. with the usual optical and 600 g. with the usual mechanical dilatometer. Alloys with low strength can therefore be studied without trouble. The apparatus is described in detail and illustrated. Expansion curves are given for pure Al (Hoopes') from room temperature to 500°, for pure Mg from room temperature to 400°, for the alloy Elektron (Mg with 10% Al and 0.5% Mn) initially in the age-hardened state, Al-Si alloys with 13% Si, and 21% Si respectively, and an Al-Cu alloy with 10% Cu. Temperature-coefficient curves are plotted from the data. The dilatometer described is sufficiently sensitive to follow changes in constitution and age-hardening processes. Data sufficiently accurate for most purposes can be obtained for both the mean and true expansion coefficient in Al and Mg alloys up to the solidus curves. RFM (10)

9

Determination of Upper Critical Points in Antifriction Alloys. F. A. BORIN & A. A. BOCHVAR. *Tsvetnuie Metallui,* No. 2-3, Mar.-Apr. 1933, pages 101-106. The authors determined the "upper critical points" (the min. temps. of quenching at which no separation of hard crystals from liquid metal occurs) for several babbits by microscopic examination of specimens quenched in copper molds. In all cases the critical points were found to be higher than the values given in the literature. BND (10)

10

Scattering of X-rays on Silver (Zur Streuung von Röntgenstrahlen an Silber). ALEXANDER A. RUSTERHOLZ. *Helvetia Physica Acta,* Vol. 6, No. 8, 1933, pages 565-569. The absolute F value of the 220 plane of Ag for Cu $K\alpha$ radiation has been determined. The value is in agreement with the theory but is lower than the one to be expected according to Fermi when using $Z = 47$ since the K electrons do not contribute to the scattering effect. EF (10)

Eutectoid Decomposition of Aluminum-Zinc Alloys (Ueber den eutektoiden Zerfall der Aluminium-Zink Legierungen). W. BUGAKOW. *Physikalische Zeitschrift der Sowjetunion,* Vol. 3, 1933, pages 632-652. Determination of changes of hardness, density and electric resistance during ageing of quenched Al-Zn alloys showed that there are 2 stages in the precipitation process. The first is characterized by a gain in electric resistance and the second one by a decrease. The velocity of the former depends largely on composition and temperature. The resistance increase is interpreted as the result of stresses due to lattice changes. This phenomenon entails martensite-like intermediary lattices, or the formation of a new lattice does not take place and the ageing process only consists of a certain arrangement of atoms of the same kind at certain spots of the lattice which, in analogy to duralumin alloys, happens at low temperatures. This "preparatory" phenomenon is characterized by a gain of resistance without changes of the micro- and X-ray structure. EF (10)

Alloys of Iron and Manganese—Part XII. Alloys of Iron and Carbon with 2.5 and 4.5% Manganese. M. GENSAMER. *Transactions American Society for Steel Treating,* Vol. 21, Nov. 1933, pages 1028-1034. Sections of Fe-C-Mn diagram at 2.5 and 4.5% Mn were constructed from an examination of 12 alloys of high purity and C content up to 1.3%. WLC (10)

Status of the Production of Dynamo and Transformer Sheet (Stand der Erzeugung der Dynamo—und Transformatorbleche). W. EILENDER & W. OERTEL. *Stahl und Eisen,* Vol. 54, Apr. 26, 1934, pages 409-414. The effect of strain in increasing the hysteresis of electric sheet is discussed, as well as the influence of grain size, impurities, and gas content. On heating in H_2 a marked decrease in hysteresis resulted even though the grain size remained the same; the decrease in hysteresis was attributed to the removal of impurities. SE (10)

A Method of Preparing Single Crystals (Eine Methode zur Erzeugung von Einkristallen). A. L. FROIMAN & P. A. POLIBIN. *Physikalische Zeitschrift der Sowjetunion,* Vol. 3, No. 6, 1933, pages 627-631. Experiments on hexagonal single crystals of Zn prepared by a modified Bridgeman method. The orientation of the growing single crystal is produced by different geometric forms of the tube. EF (10)

Crystal Structure and Electric Properties. IV. Conductivity Areas of the Bismuth Crystal, Part I (Kristallstruktur und elektrische Eigenschaften. IV. Die Leitfähigkeitsflächen des Wismutkristalls, 1. Teil). O. STIERSTADT. *Zeitschrift für Physik,* Vol. 87, No. 11/12, 1934, pages 687-699. It is shown by theoretical deductions and experiments on Bi crystals that, in general, the distribution of conductivity in a metallic crystal must be an image of its lattice symmetries. Ha (10)

Structure and Growth of Thin Surface Layers on Metals under Oxidation in Air (Struktur und Wachstum dünner Oberflächenschichten auf Metallen bei Oxydation an Luft.) A. STEINHEIL. *Annalen der Physik,* Series 5, Vol. 19, Mar. 1934, pages 465-483. Films which form on metals under the influence of air (as on Al and Sn) were studied by chemical composition, properties, structure, and growth. The film on Al, for example, shows the X-ray spectrum of a face-centered cube with $a = 5.35$ A. U.; it is probably an anhydrous Al_2O_3 of so-far unknown structure (ϵ-Al_2O_3). Thickness of an Al film was 4×10^{-8} cm. If the firm is recovered by melting off from the metal or if it is heated, it reverts to the known γ—Al_2O_3 structure. Sn films consist of tin oxide and tin dioxide, of thickness about 4×10^{-6} cm. Ha (10)

Heat Effect on Tempering Quenched Carbon Steels (Die Wärmetönung beim Anlassen abgeschreckter unlegierter Stähle). H. ESSER & W. BUNGARDT. *Archiv für das Eisenhüttenwesen,* Vol. 7, Apr. 1934, pages 585-586. The heat evolved on tempering quenched 1 to 1.7% C steels up to 600°C. was determined in a specially built water calorimeter. The amount of retained austenite in the quenched samples was determined magnetically. The retained austenite rose from 10% in the 1% C steel to 65% in the 1.7% C steel; the heat effect in tempering rose from 10 to 24 cal/g. SE (10)

The Latent Heat of the Austenite-Martensite Transformation (Die Wärmetonung der Austenit-Martensit-Umwandlung). H. ESSER & W. BUNGARDT. *Archiv für das Eisenhüttenwesen,* Vol. 7, Mar. 1934, pages 533-536. The heat content in the temperature range 300 to 900°C. of Ag, a 20% Mn Fe-Mn alloy, and 3 steels containing 0.5, 0.8, and 1.4% C were determined in a specially built water calorimeter. In determining the heat effect of the austenite-martensite transformation from the heat content temperature curves of the quenched carbon steels, allowance was made for the amount of austenite retained on quenching. The values (referred to 721°C.) obtained were 13.6, 11.9, and 11.4 cal/g for the 0.5, 0.8, and 1.4% C steels respectively. SE (10)

Dynamics of Chemical Transformations. Austenite-Martensite-Ferrite (Zur Dynamik chemischer Umwandlungen. Austenit-Martensit-Ferrit). O. ENGELMANN. *Die Metallbörse,* Vol. 24, Feb. 17, 1934, page 209; Feb. 24, 1934, pages 241-242. Constitutional diagrams must be applied with intelligence since they are based on equilibrium conditions which are often far from prevailng in metallurgical operations. Supplement by energetic-kinetic investigations is urged. Tests of Wever on the dynamic reactions in Cr-Ni steels are cited at length. Oxide precipitation may narden metals to a considerable extent. Attention is called to the rare earths, which were considered to be very brittle, but later proved to be highly ductile after they could be prepared in the pure state by halide dissociation. EF (10)

Change in Form of Cadmium Crystals upon Reversed Torsion (Über die Gestaltsänderung von wechseltordierten Kadmiumkristallen). W. FAHRENHORST & H. EKSTEIN. *Zeitschrift für Metallkunde,* Vol. 25, Dec. 1933, pages 306-308. The change in cross-section of Cd crystals subjected to 100,000 cycles of reversed torsion are analyzed from the standpoint of resolved stresses and the known slip mechanism in Cd. RFM (10)

Observation of Opaque Objects in Polarized Light (Zur Frage der Beobachtung undurchsichtiger Gegenstände mit Hilfe von polarisiertem Licht). O. FEUSSNER. *Zeitschrift für Metallkunde,* Vol. 25, Dec. 1933, pages 313-314. Minerals and rocks are usually studied in parallel polarized light in order to distinguish details in structure; individual crystals may be studied in a convergent beam, but with this, distinction of structural constituents is impossible. Parallel polarized light is not possible in the observation of opaque substances and thus the usefulness of the method is limited. Metallic reflection and spurious reflections from etch pits are further hindrances. Theoretical foundations for the application of the method are lacking. *Discussion.* M. v. SCHWARZ ibid, page 314. S's application of polarized light was undertaken with full appreciation of the difficulties mentioned by F. Tronstad (*Z. tech. Phys.* vol. 13, 1932, page 408) has devised a diaphragm permitting the use of parallel polarized light. Despite limitations in theory, the success attending the observation of segregation, slip lines, twinning, and internal strains cannot be doubted. *Reply.* O. FEUSSNER, ibid, page 314. Tronstad's contrivance does not produce complete convergence. The observation of segregation, etc., is not direct, but depends on a correlation with other, chiefly ordinary microscopic, observation. RFM (10)

Identity of Laws of Curie Points and of Melting Points (Sur l'identité de la loi des points de Curie et celle des points de fusion). R. FORRER. *Société française de physique,* No. 349, Jan. 19, 1934, pages 12-13. Law of Curie points $\Theta = F\sqrt{N}$ also holds for melting points. If one assumes the following F values $F_{Fe} = 301$, $F_{Co} = 289$ and $F_{Ni} = 315$, the melting points of Ga, In, Pb and Sb arrange at 1, 2, 4 and 9 F_{Fe}, and those of Rb, Li, Bi, As and Au at 1, 2, 3, 12 and 18 F_{Ni}, and Cs, Sn, Tl, Mg and Ag at 1, 3, 4, 10 and 18 F_{Co}. WH (10)

Heat Content and Specific Volume of the Iron-carbon Alloys (Wärmeinhalt und spezifisches Volumen der Eisen-Kohlenstoff-Legierungen). G. TAMMANN & G. BANDEL. *Archiv für das Eisenhüttenwesen,* Vol. 7, Apr. 1934, pages 571-578. A correlated abstract summarizing the existing data on the heat content, specific heat, and density of the iron-carbon alloys in graphs and solid figures. The effect of temperature and pressure on these values and the changes at the transformations and on melting are also shown. SE (10)

Supposed Allotropy of Antimony (Ueber die angebliche Allotropie des Antimons). A. SCHULZE & L. GRAF. *Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt,* Berlin, Vol. 16, No. 2, 1933, pages 459-462. See *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 275. EF (10)

The Structure and Constitution of Alloy Steel. OWEN W. ELLIS. *Transactions American Society for Metals,* Vol. 22, Feb. 1934, pages 139-187; *Iron Age,* Vol. 132, Sept. 28, 1933, pages 14-17, 82; Nov. 2, 1933, pages 21-24; Vol. 133, Jan. 18, 1934, pages 20-23. Reports of methods used in studying conditions for formation of Widmanstätten structure in steel: C, 0.33%; Mn, 0.69%; Ni, 1.30%; and Cr, 0.73%. Methods employed indicated that four critical points exist in this steel, under suitable cooling. At Ar_3', part of face-centered solid solution transforms into body-centered solution; at Ar_1', saturated face-centered solution in vicinity of body-centered solid solution already formed transforms into "conglomerate" of body-centered solid solution and carbide; at Ar_3'', such face-centered solution as remains changes into body-centered solid solution, which precipitates in form of needles and at Ar_1'', saturated face-centered solution lying between the needles changes into "conglomerate." The alternate needles of body-centered solid solution and interstitial conglomerate form Widmanstätten structure. Certain conditions of cooling may cause Ar_3' and Ar_1' only; Ar_3'' and Ar_1'' only; all points: or, when critical rate is exceeded, only Ar_1'' will appear. Discussion by Col. N. T. Belaiew brings out that the cooling rate which favors the formation of this structure in this steel is 2°-4.5°C./sec. in range 850°-350°C. VSP + WLC (10)

Strain Hardening Phenomena in Pressed Metallic Powders (Ueber Verfestigungserscheinungen an gepressten Metallpulvern). W. TRZEBIATOWSKI. *Zeitschrift für physikalische Chemie,* Abt.B, Vol. 24, Jan. 1934, pages 75-86. Finely divided Au and Cu powders were submitted to compression up to 30 x 10^3 atm. The samples exhibited a tremendous gain in strength. X-ray diagrams show widening of lines and increase of scattered radiation but not the formation of any texture. Hardness and density measurements of samples, prepared at various pressures and subsequently annealed, were made. Hardness values were secured which were never before attained on even highly deformed metals. This is attributed to the marked strain-hardening effects and to the particularly finely crystalline structure of the compressed bodies. Further interpretation possibilities are discussed. On annealing, a drop in hardness takes place due to recrystallization. Density changes during annealing of the synthetic metallic bodies are ascribed to the escape of sorbed gas, quantities diffusing off more or less readily according to the preparation pressure and sintering processes applied. Previous work is cited. EF (10)

Alloys of Iron, Manganese and Carbon—Part VIII. Influence of Carbon on 10% Manganese Alloys. JOHN F. ECKEL & V. N. KRIVOBOK. *Transactions American Society for Steel Treating,* Vol. 21, Sept. 1933, pages 846-864. The 10% Mn, 0.01-1.40% C section of the Fe-C-Mn diagram, showing regions of gamma solid solution, alpha solid solution, and carbides is reported. Other diagrams show the influence of composition and previous treatment on decomposition of gamma phase. Diagrams showing hardness after various treatments are discussed. Se also "The Influence of Carbon on 10% Manganese Alloys," *Metals & Alloys,* Vol. 5, Jan. 1934, page MA 30. WLC (10)

A New Method of Preparing Specimens of Dust (Ein neues Staubschliff-Verfahren). E. STACH. *Glückauf,* Vol. 70, Feb. 17, 1934, pages 155-159. Method consists of saturating the dust (metal, coal, mineral) with liquid, black carnauba wax, which produces a very close arrangement of the grains for observation under the microscope. Sorting and classifying is made easier in this manner. Ha (10)

Inverse Segregation. H. SUTTON. *Metallurgist* (Supplement to *The Engineer*), Apr. 28, 1933, pages 22-24, June 30, 1933, pages 35-36. A review of 12 recent references. VVK (10)

Preferred Orientation Produced by Cold Rolling Low Carbon Sheet Steel. WAYNE A. SISSON. *Metals & Alloys,* Vol. 4, Dec. 1933, pages 193-198. X-ray study of the preferred orientation in cold-rolled sheet (C 0.4%. Mn 0.04%, S & P 0.014%) is reported. Rolling was carried out on Steckel, conventional, and hand-operated rolling mills. Samples were located away from the center of the strip and their optimum thickness was determined to be 0.08 to 0.1 mm. 84 samples taken after each pass from four series of rollings were examined. Various reductions per pass fom one initial size were studied. WLC (10)

Application of Metallography in the Study of Failures of Steam Boilers (L'Application de la Métallographie à l'Etude des Avaries des Chaudières à Vapeur). ROBERT STUMPER. *Chaleur et Industrie,* Vol. 14, Nov. 1933, pages 511-515. Failures in boilers are due to one of the following causes: (1) Defects in steel used. (2) Defects in construction of boiler. (3) Defects in service operation. (4) Insufficient control. (5) Insufficiently pure feed water. In all these cases metallography can be used to detect the cause and therefore to obviate the same failure in the future. Composition of boiler steel-plates is dealt with and it is emphasized that non-metallic inclusions have effects in steel which are not yet well known. Recent research results would tend to impute some aging effect to N, As, and O. Different factors are likely to modify considerably the size and arrangement of ferrite and pearlite; viz., (1) temperature, (2) mechanical treatment, (3) time. Little is known about the 3d factor, except about effect of cooling rate after anealing. It must be borne in mind that boilers are in service during long time at relatively high temperatures; this produces heat treatment which cannot be reproduced in laboratories, so that it is not surprising to note anomalous or unaccountable structures when studying boiler plates or tubes. When failures are due to mechanical stresses, this can be proved by metallographic study. Chemical effect of water or steam can also be traced under the microscope. Fe-C diagram and micrographs are used to explain mechanical and chemical effects as well as effects due to heat treatment. FR (10)

Transformation of Austenite in High-speed Steel (Die Umwandlung des Austenits im Schnellarbeitsstahl). S. STEINBERG & V. SÜSIN. *Archiv für das Eisenhüttenwesen,* Vol. 7, Mar. 1934, pages 537-538. The transformation of austenite in a high-speed steel, containing 0.75% C, 17% W, 4% Cr, and 1% V, on cooling to subcritical temperatures was followed by magnetic measurements. The austenite was remarkably stable in the temperature range 600-400°C. and at 200°C. In the range 600-800°C. the austenite breaks down to troostite; in the range 400-200°C. martensitic needles are formed. On tempering to 600°C. the retained austenite transforms to martensite only during the subsequent cooling to below 200°C., not during the heating or during holding at 600° C. SE (10)

On the Equilibrium Diagram of the System Nickel and Zinc (The Second Report). KANZI TAMARU & ATOMI ÔSAWA. *The Bulletin of the Institute of Physical & Chemical Research,* Tokyo, Vol. 13, Mar. 1934, pages 125-140. In Japanese. *Scientific Papers & Abstracts of the Institute of Physical & Chemical Research,* Tokyo, Vol. 23, Mar. 1934, pages 13-14. In English. Differential thermal analysis, specific-gravity measurement, and microscopic examination were employed to study the cause of cracking of the crucible, especially with alloys around 10% Ni. X-ray analysis yielded the following conclusions: (1) A peritectic reaction occurs at 517°C. between γ and ϵ phases. The range of this reaction lies between 13.5-0.5% Ni. (2) The volume of the alloys containing 10-11% Ni increases by about 3% due to the formation of the ϵ phase. (3) The α solid solution has a face-centered-cubic lattice. The parameter increases very rapidly up to 20% Zn, then less rapidly, reaching 3.592 A.U. at 38.9% Zn. (4) The β-solid solution has a body-centered-tetragonal lattice of the following dimensions: a = 2.724 A.U., $c = 3.168$ A.U., $\frac{c}{a} = 1.163$. (5) The γ-solid solution is body-centered cubic. The edge of the elementary cell is a = 8.927 A.U. and there are 52 atoms per unit cell. Compound $NiZn_3$ was considered to the γ-solid solution in the first report, but X-ray analysis revealed the existence of Ni_2Zn_{10}. (6) The δ-solid solution is face-centered tetragonal with the following dimensions: a = 3.867 A.U., $c = 3.203$, $\frac{c}{a} = 0.8278$. (7) The ϵ phase containing 50 atoms per elementary cell is tetragonal. This phase contains 10.9% Ni, has the chemical formula Ni[illegible]Zn[illegible], and the following dimensions: a = 8.922 A.U., c = 9.254 A.U., $\frac{c}{a} = 1.0372$. See also *Metals & Alloys,* Vol. 4, June 1933, page MA 172. WH (10)

Mechanism of Plastic Deformation (Ueber den Mechanismus der plastischen Deformation). A. W. STEPHANOW. *Physikalische Zeitschrift der Sowjetunion,* Vol. 4, 1933, pages 609-627. See *Metals & Alloys,* Vol. 5, May 1934, page MA 214. EF (10)

On the Influence of Hydrogen on the Transformations in Iron. HANS ESSER & HEINZ CORNELIUS. Discussion by R. H. Harrington. *Transactions American Society for Steel Treating,* Vol. 21, Aug. 1933, pages 733-740, Oct. 1933, pages 896-898. See "Effect of Hydrogen on the A_3 and A_1 Transformations in Iron," *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 152. WLC (10)

X-ray Investigation of the Compound MgZn and $MgZn_5$ (Röntgenographische Untersuchung der Verbindungen MgZn und $MgZn_5$). L. TARSCHISCH. *Zeitschrift für Kristallographie,* Vol. 83, Nov. 1933, pages 423-438. The question of the existence of MgZn is answered in the affirmative. The most stable compound in the system Mg-Zn is $MgZn_5$. Due to diffusion of Mg into the Zn lattice preliminary formed $MgZn_5$ changes into the complicated compound MgZn. The author discusses at great length the inter- and intralattice forces present in intermetallic compounds. EF (10)

Thermal and Mechanical Separation of Atomic Structures in Metals (Ueber die Zusammenhänge bei der thermischen und mechanischen Lösung der atomaren Bindungen in Metallen). F. REGLER. *Annalen der Physik,* Series 5, Vol. 19, Apr. 1934, pages 637-664. X-ray investigations of metals revealed that the width of the lines is increased by any kind of mechanical stress and by increase of temperature. Every crystal lattice of a metal (element or chemical compound) can only absorb a definite value of potential energy which is characteristic for the metal under test; if more energy is supplied the atomic structure is loosened. A sample of Ag, for instance, showed at the place of fracture the same width of lines as that observed at the melting point of the metal. The widening of interference lines is due not to a deformation of elementary cells but to a change in the crystal lattice of the elementary cell. To every energy content of a crystal lattice a definite lattice type must be ascribed; the change of the lattice type must be regarded as a quantum phenomenon which does not follow the laws of classical mechanics. Ha (10)

Metallography Controls Steel Wire Manufacture. T. A. BISSELL. *Iron Age,* Vol. 133, May 17, 1934, pages 18-19. VSP (10)

PROPERTIES OF METALS & ALLOYS (11)

Magnetic Properties of Cerium, Lanthanum and Neodymium at Various Temperatures (Propriété Magnétiques du Cérium, du Lanthane et du Néodyme Metalliques à Diverses Temperatures). F. TROMBE. *Comptes Rendus*, Vol. 198, Apr. 30, 1934, pages 1591-1593. Metals used were spectrographically free from Ca with traces of Si and Fe. Magnetic apparatus same as that used by Foëx and Forrer. The variations of the magnetic susceptibility with field intensities (measured in gauss) was studied for different temperatures. Curves given of $1/\chi$ (susceptibility) as a function of the absolute temperature (T). FHC (11)

Temperature Coefficient of Electrical Resistance and Temperature Coefficient of resistivity of Metals. (A Correction Necessary in Precision Measurements of the Temperature Coefficient of Resistivity) (Coefficiente di temperature della resistenza elettrica e coefficiente di temperatura della resistivita dei metalli (Una correzione necessaria nelle misure di precisione dei coefficienti di temperatura della resistivita.) O. SCARPA. *La Metallurgia Italiana*, Vol. 26, Apr. 1934, pages 243-244; *Allumino*, Vol. 3, Mar.-Apr. 1934, page 63. The value of the average temperature coefficient for an electrical conductor between the temperatures t_2 and t_1, is usually calculated by the expression

$$\alpha_r = \frac{r_2 - r_1}{r_1\,(t_2 - t_1)} \qquad r_1 = \text{resistance at } t_1$$

whereas, the more precise form

$$\alpha_r = \frac{r_2\,(1 + a\,(t_2 - t_1)) - r_1}{r_1\,(t_2 - t_1)}$$

should be used, as in many cases, the value of $a(t_2 - t_1)$ is not negligible. Thus, for Al between 10 and 90°C., the value of the expression is 1.002. This makes the average value of the coefficient when the approximate equation is used, 0.00390 while the rigorous equation gives 0.00393. AWC(11)

Non-Ferrous (11a)

A. J. PHILLIPS, SECTION EDITOR

Influence of Cross-Section in Cast Aluminum Alloys (Einfluss des Gussquerschnittes bei Aluminiumlegierungen). M. FRH. v. SCHWARZ *Zeitschrift für Metallkunde*, Vol. 25, November 1933, pages 269-274. Four alloys were studied: (1) "Normal German Alloy." 84% Al, 14% Zn, 2% Cu; (2) "Normal American Alloy," 92% Al, 8% Cu; (3) "Self-hardening Germany Alloy," 83% Al, 13% Zn, 3.8% Cu, 0.2% "hardening additions"; (4) "Self-hardening American Alloy," 90% Al, 9.8% Cu, 0.2% "hardening additions." These alloys were sand cast and tensile, hardness, and bending tests performed on samples cut from different positions in the casting in order to evaluate the effect of cross-section. The data are shown in a series of graphs. The yield point is a much more valuable indication of engineering usefulness than the ultimate strength. With discussion. RFM (11a)

The White Alloys of Tin. III. Pewter. *Tin*, Apr. 1934, pages 19-22. History of pewter is briefly related. While old pewter contained up to 25 Pb and was consequently, very soft and injurious to health as it was readily attacked by organic acids and liquids, modern pewter has usually the following composition:

Cu	3 to 8%	or	2.5 to 3%
Sb	1.5 to 5%	or	1.5 to 2%
Pb	nil	or	nil
Sn	90 to 92%	or	95-96%

The hardeners (Cu and Sb) are added to the molten Sn; the alloy can be cast directly into the forms finally desired; pouring temperature 345°-375° C. according to Sn content. The artistic treatment of pewter ware is discussed. Ha (11a)

Production and Properties of Cadmium (Herstellung und Eigenschaften des Kadmiums). EDMUND T. RICHARDS. *Die Metallbörse*, Vol. 24, Feb. 29, 1934, pages 242-243; Mar. 3, 1934, pages 273-274. Occurrence of Cd in galena and flue dust of Pb smelterics, dry metallurgical production processes, wet processes and electrolysis, properties and utilization of Cd. A typical analysis of commercial Cd shows 99.84% Cd, .1% Zn, .021% Fe, .005% Cu, .005% S, .004% Pb, .009% As and occasionally low amounts of Ni and Tl. The white Cd oxide forming at the surface protects the underlying metal, but it can be easily wiped off. Thus Cd shows an inferior protection to Sn in out-door exposure, but 5-6 times longer life times in indoor tests including moist atmospheres. Cd is harder than Sn and softer than Zn which gives an advantage to Cd plating. The m.p. of eutectics of binary systems are: Bi-Cd (55.5:44.5) = 146° C., Sn-Cd (67.6:32.4) = 177° C., Pb-Cd (63.0:37.0) = 249° C. The eutectic of the quaternary alloy of 49.5 Bi, 27.3 Pb, 13.1 Sn and 10.1 Cd melts at 70° C. and the Lippowitz metal at 55° C. corresponding to an alloy of 50 Bi, 26.7 Pb, 13.3 Sn and 10 Cd. EF (11a)

Zinc Die Casting Alloy. Aging Data. E. A. ANDERSON & G. L. WERLEY. *Metals & Alloys*, Vol. 5, May 1934, pages 97-99 & 102. Dimensional changes, tensile strength, elongation, hardness and intergranular corrosion of five zinc base die casting alloys all containing 4.1% Al, and 2.9% Cu with 0.04% Mg, no Cu with 0.04% Mg, 1.0% Cu with 0.04% Mg, 1.25% Cu with no Mg, and 2.9% Cu with no Mg, were studied. Results indicate rapid aging occurs in all alloys with small shrinkage and increase in ductility, room temperature tests should be supplemented by elevated temperature tests where such service is expected and steam test data must be corrected for temperature effects for correct evaluation. WLC (11a)

Zirconium. GORDON H. CHAMBERS. *Metals & Alloys*, Vol. 4, Dec. 1933, pages 199-201. The use of Zr powder for flashlight mixture, ammunition primers and other ignition purposes are described. The metal is prepared by a thermit process, is extremely fine but may be safely handled at ordinary temperatures, ignition point 210° C., and addition of water makes shipment quite safe. Its very high resistance to hydrochloric and nitric acids is cited. Its metallurgical uses as a deoxider for monel, nickel silver and copper alloys is discussed. Zr carbide tools and ductile metal are briefly described. WLC (11a)

Hardenable Beryllium Alloys (Vergütbare Berylliumlegierungen). J. F. SACHER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Mar. 25, 1934, pages 187-188. Author discusses (1) production of Be by electrolysis according to methods of Siemens & Halske and Beryllium Development Corporation, (2) properties, (3) heat treatment, (4) application. GN (11a)

Investigations into the Dependence on Frequency of Elasticity under Torsional Oscillations (Untersuchungen über die Frequenzabhängigkeit der Elastizität bei Torsionsschwingungen). DANKWART SCHENK. *Zeitschrift für Physik*, Vol. 88, No. 9/10, 1934, pages 626-633. The dependence of the torsion modulus on frequency is examined on Ni, Cu, Al, brass and glass. The elasticity depends on the deformation factor; if this factor becomes negative, that is when the dynamic torsion modulus is smaller than the static modulus, fracture of the material occurred. This is because at some place a deformation takes place which is too great for recovery; energy is absorbed at this place and the factor becomes negative. Ha (11a)

Beryllium-Copper Castings: Foundry Practice, Heat Treatment and Properties. EDWIN F. CONE. *Transactions & Bulletin, American Foundrymen's Association*, Vol. 4, Dec. 1933, pages 330-346. See *Metals & Alloys*, Vol. 5, May 1934, page MA 219. CEJ (11a)

The Homogeneous Electro-Thermic Effect in Liquid and Solid Metal III (Der elektrothermische Homogeneffekt im flüssigen und festen Metal. III). C. BENEDICKS & G. SILJEHOLM. *Arkiv för Matematik, Astronomi och Fysik*, Vol. 24, Sect. A, No. 7, 1933, 36 pages. The experimental facilities for studying the previously discovered homogeneous electro-thermic effect have been greatly improved and the course of this phenomenon predicted on the basis of the phoretic theory has been corroborated on constantan, Cu and Hg in regard to the sign as well as to the relative magnitude of this effect. The latter was found to increase proportionally with the current intensity. EF (11a)

Hydronalium, the V_2A-Steel of Light Alloys (Hydronalium, der V_2A-Stahl der Leichtlegierungen). *Oberflächentechnik*, Vol. 10, Nov. 7, 1933, pages 246. The highly corrosion-resisting hydronalium, an Al alloy with 7% Mg and 0.5% Mn, finds a wide field of application in naval construction and hydroplanes; its mechanical properties are:

	elastic $\sigma = 0.02\%$ kg/mm.²	limit $\sigma = 0.2\%$ kg./mm.²	tensile strength kg/mm.²	elong. %	red. of area %	Brinell hardness
Sand castings	8-9	11-13	18-30	3-5	3-5	60-65
Die castings	11-15	15-20	31-35	16-22	17-25	75-80
Chill castings	9-10	12-13	23-25	9-12	13-15	70
Sheet, soft	11-14	15-18	31-36	16-22	15-20	75-80
Sheet, medium-hard	18-24	20-25	35-40	6-14	....	....
Sheet, hard	28-30	30-36	38-43	4-9	....	....

Density 2.63, melting point 615° C., elasticity modulus 700,000-730,000 kg./cm.² The melt must be refined with a mixture of magnesium chloride and fluorspar, castings are molded in green sand with 10% S and 0.35-0.75% boric acid. The metal is refined by annealing at 425° C., quenching, and tempering at 150°. Instructions for machining are added. Ha (11a)

Copper, With Its Alloys, Has Many Important Uses in Every Branch of Petroleum Industry. L. G. E. BIGNELL. *Oil & Gas Journal*, Vol. 32, Nov. 9, 1933, pages 14, 20. General review of properties and uses of copper alloys. Contains table of analyses of about 40 commercial Cu alloys. VVK (11a)

Effect upon the Electrical Conductivity of Aluminum of Additions of Magnesium, Silicon, Vanadium, Chromium, Manganese, Iron, Cobalt, Nickel, Copper, Zinc, Arsenic, Silver, Cadmium, Tin, Antimony, Lead and Bismuth (Über die Beeinflussung der elektrischen Leitfähigkeit des Aluminiums durch Zusätze von Magnesium, Silicium, Vandin, Chrom, Mangan, Eisen, Kobalt, Nickel, Kupfer, Zink, Arsen, Silber, Kadmium, Zinn, Antimon, Blei und Wismut). H. BOHNER. *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, pages 45-47. To a base alloy containing 0.07 to 0.20 Si, and 0.04 to 0.32% Fe (one exceptional alloy with 1.19% Fe), additions of the elements listed in the title were made. The conductivity of the wires annealed at 300° was throughout higher than that of the wires annealed at 500-550°. As, Cd, Zn, Sn, Fe, Ni, Co, Pb, and Bi have little effect upon the conductivity, but a few hundredths of a per cent of V, Cr, or Mn decrease it greatly owing to the formation of solid solutions. It is not possible to avert this diminution by the formation of a ternary compound with an added element. Si, Ag, Cu, and Mg also decrease the conductivity owing to solid solution formation, but the effect is smaller than with Cr, Mn, and V, and can be largely averted with alloys with Cu and Si by annealing between 250 and 300°. RFM (11a)

Heat Teatment of Aluminum Casting Alloys (Die Vergütung von Aluminiumgusslegierungen) *Zeitschrift für die gesamte Giessereipraxis*, Vol. 54, Dec. 24, 1933, pages 531-532. Mechanical properties of both sand as well as die cast Al alloys are improved by special heat treatment. Two main types of such alloys must be distinguished: (1) Cu bearing alloys (German alloy, American alloy, Lautal cast alloy L IV, Y-alloy, etc.) are improved after heating and quenching by aging at 130°-150°C.; aging at room temperature brings about no improvement, (2) Mg-Si-Al alloys (for instance Silumin-β and Silumin-γ) though aging at room temperature are also artificially aged at 130°-150° C. Aging process is considered. In the German and American alloy highest mechanical properties are attained after quenching from 500°-520°C. and aging at 130°-140° C. L IV (4% Cu, about 2% Si, balance Al) is heated to 450°-510°C. for several hours, quenched in water at room temperature and aged in oil or air for at least 2 hrs. at 140°-150° C. The following properties are then attained.

	Yield Point kg./mm.²	Tensile Strength kg./mm.²	Elongation %	Brinell Hardness
Sand cast hardened	8-10	12-20	about 4	55-70
Sand cast hardened	12-18	16-25	about 10	80-90
Mold cast hardened	8-10	17-25	about 4	70-80
Mold cast hardened	15-25	20-30	about 10	90-110

In heat treating Silumin-β (in improved state it is called Silumin-γ) which contains 12% Si, 0.3% Mg, .5% Mn, balance Al, best properties are attained by heating at 510° C. for 3 hrs., quenching in H_2O and aging at 150° C. for 20 hrs. Results are attained as given in table below. For all such alloys close observance of heating and aging temperatures is highly important.

Alloy and condition	Yield Point kg./mm.²	Tensile Strength kg./mm.²	Elongation %	Brinell Hardness	Endurance Bending Strength kg./mm.²
Silumin-β sand cast	9-10.5	17-20	2-5	55-65	6.5
Silumin-β Mold cast	13-15	23-25	2-3	75-85	10
Silumin-γ sand cast	18-25	25-29	4-0.5	80-100	8.5
Silumin-γ mold cast	20-28	26-32	1.5-.5	85-110	11

GN (11a)

Silver Alloys for Processing Utensils (Edle Silberlegierungen zur Herstellung von Gebrauchsgegenständen). *Deutsche Goldschmiedezeitung*, Vol. 37, Mar. 10, 1934, pages 112-113. Common Cu-Ag alloys for mentioned parts have the disadvantage of absorbing O during melting process and possessing but a limited solubility in solid state. Investigations by Leroux, carried out at Probier- und Forschungsanstalt für Edelmetalle at Schwabisch-Gmünd, Germany, on alloys containing about 81-92% Ag, 1-2% Ni, 2-5% Cu and 10-12% Zn showed a rather complete formation of solid solutions and essentially increased stability against oxidation and attack of organic acids as compared with common Cu-Ag alloys. In these new alloys gas inclusions that impair considerably machinability are not observed. According to investigations of Beryllium Corporation of America highly corrosion resistant Ag alloys are obtained by adding up to 5% Be to pure Ag or Ag alloys. Difficulty of making such alloys by directly alloying Be is eliminated by applying in alloying process preliminary Be alloys with 30-60% Be. Be content of Ag-Be alloys should not exceed 5% since above 5% Be alloys are brittle and not machinable. Electrolytic processing method of this alloy is briefly outlined. GN (11a)

The Hall Effect and Some Other Physical Constants of Alloys. Part II. The Tin-Bismuth Series of Alloys. W. RHEINALLT THOMAS & E. J. EVANS. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science*, Vol. 17, Jan. 1934, pages 65-83. Effect of variation of composition of an alloy on its physical properties was investigated for Sn-Bi alloys, in particular the effect on the Hall coefficients. Electric resistivity had its maximum value (359.6 microhm/cm.³) at about 99.5% Bi, the mean temperature coefficient of the resistance a minimum of 13.32 $\times$ 10⁻⁴ at 98%; the thermo-electric power had a maximum of +22.2 microvolt per °C. with reference to Cu at 94% Bi and changed to negative values at about 72% and 99.2% Bi. Hall coefficients also show, at different magnetic fields maxima at between 93-99% Bi. Physical properties of Sn-Bi alloys resemble Pb-Bi alloys. 14 references. Ha (11a)

Copper in Alloys (Le Cuivre dans les Alliages). L. Houllivigue. *Cuivre et Laiton*, Vol. 7, Apr. 15, 1934, pages 159-161. Lists various alloys containing Cu and physical properties are briefly discussed. Ha (11a)

Characteristics and Conditions of Use of Some Cuprous Alloys as Bearing Metals (Caractéristiques et Conditions d'Emploi de Quelques Alliages Cuivreux comme Métaux de Frottement.) M. A. Ricard & H. Ackerman. *Cuivre et Laiton*, Vol. 6, May 30, 1933, pages 239, 242. Cu-containing alloys are used successfully as anti-friction metals because of their crystalline dendritic structure and quick solidification; the Cu-content gives them the property of being plastic which is essential for cold-working of bearing metals. A study of bearing bronzes with 8-20% Sn was made. These are now generally used industrially; alloys with less than 8% Sn show mainly the α-phase in a heterogeneous form, while with more than 10% the eutectoid $\alpha + \gamma$ formed with an increase in the interval of solidification; they are particularly suitable as antifriction metals as they contain elements of great hardness and yet retain good plastic properties. In bronzes with more than 14% Sn the hard and brittle constituents have increased so much that the alloys are not plastic. With improved methods of lubrication it is now possible to reduce the formerly quite generally accepted ratio of 1.5 of length to diameter of a bearing to 1.0 or even 0.6 as exemplified in modern Diesel engines where bearings work under great stress. Ha (11a)

Magnesium Alloys Reduce Weight-Strength Ratio. *Machine Design*, Vol. 5, Nov. 1933, pages 28-30. Principal alloys discussed are:

Alloy	Mg	Al	Mn	sp. gr.	m.p. °F.	thermal cond. in CGS units 100°-300° C.	electric resistivity microhms/cm³ at 20° C.
M	98.5	—	1.5	1.76	1200	0.30	6.5
F	95.7	4.0	0.3	1.77	1160	0.23	9.5
E	93.7	6.0	0.3	1.79	1140	0.20	11.0
A	91.8	8.0	0.2	1.80	1120	0.18	13.0
G	89.9	10.0	0.1	1.81	1100	0.17	15.0

Coefficient of expansion of all alloys per °F. = .000016. "M" has maximum corrosion resistance, and is primarily for fabricated parts not subjected to high stress. "F" is suitable for forging, rolling, extrusion, etc., where maximum ductility is required. "E" is used for castings requiring good strength without heat treatment. "A" has high strength, high ductility, its castings may be heat treated and are useful for parts requiring high strength. "G" is used in the form of heat treated castings where high yield strength and hardness are of prime importance. Mg alloys lend themselves readily to machining and joining. They take a rough cut of 1/8"-3/16" at 200-600 ft./min. and a finishing cut of 1/16"-1/32" at 1000-1400"/min. Welding by the acetylene, electric spot or seam process is feasible. Standard Al alloy rivets are used because they can be driven cold. Some of the more important physicals of alloys mentioned above are:

Alloy	Tensile strength lbs./in.²	% elongation 2 in.	Brinell hardness	Impact toughness	Compressive strength lbs./in.²	Shear strength lbs./in.²
A cast	32-36,000	8-12	47-50	10-14	44-48,000	16-18,000
B cast	30-35,000	3-6	57-63	4-8	48-53,000	19-21,000
E extruded	40-45,000	11-17	51-55	16-19	58-63,000	19-21,000
F extruded	38-42,000	14-18	45-50	12-16	57-61,000	19-21,000
forged	34-39,000	7-15	46-28	....	....	....
rolled	32-37,000	5-13	52-62	....	....	....
M-extruded	39-45,000	4-9	39.46	7-13	....	17-20,000

WH (11a)

Transformations in the Copper-palladium Alloys. R. Taylor. *Journal Institute of Metals*, Vol. 54, 1934, 20 pages (Advance copy). Cu-Pd alloys containing up to 55 at. % Pd were examined by thermal, microscopic, and electric-resistance methods. Measurements of resistance were made at different temperatures, the wires being kept at each temperature until the resistance became constant. The occurrence of transformations in the ranges 10-30 and 35-50 at. % Pd were associated with different types of temperature-resistance curves. The minimum resistance in the Cu-rich ordered (superlative) state occurred in the 15 at. % alloy. The minimum resistance in alloys of higher Pd content occurred at 47 at. % Pd. The results are compared with those of earlier workers and the mechanism of the transformations is discussed. Minima in resistance in the ordered state do not occur at 25 and 50 at. % Pd because the dilation of the Cu lattice by Pd opposes the decrease in resistance brought about by ordered arrangement of the atoms. 9 references. JLG (11a)

Surface Tension of Gold Leaf (Die Oberflachenspannung von Goldlamellen). G. Tammann & W. Boehme. *Annalen der Physik*, Series 5, Vol. 12, Mar. 1932, pages 820-826. The surface tension of gold foils was determined by the shrinking of the crystals of the foil. This phenomenon is observed in all metallic materials at temperatures even below their melting point. The surface tension depends on the temperature and was found between 700° and 850° C. to be in the neighborhood of 1200 mg./cm. Ha (11a)

The Resistance of Some Copper Palladium Alloys. D. Stockdale. *Transactions of the Faraday Society*, Vol. 30, Feb. 1934, pages 310-314. Contains bibliography. Alloys containing 53.44 to 60.77 at. % Pd were studied. Specific resistances and temperature coefficients are given in the table. The coefficients are small and decrease as temperature rises from 1.2×10^{-4} for range 0 — 20° C. to 0.8×10^{-4} for range 100 — 148° C. for the alloy containing 54.28 at. % Pd.

Pd at. %	Sp. Resist. ohms — CMS at 20° C.	Temp. Coefficient 0 — 20° C.
53.44	42.15×10^{-6}	1.6×10^{-4}
54.28	42.8	1.2
56.31	45.75	1.2
58.02	46.6	1.1
58.53	47.15	1.3
60.77	47.0	1.6

PRK (11a)

The Gamma Radiation of Radium (Le rayonnement gamma du radium). E. Stahel & W. Johner. *Journal de physique et le radium*, Vol. 5, Mar. 1934, pages 97-103. The nature of the γ radiation of Ra has been studied. The intensity was found to be 1.2 quanta per 100 atoms disintegrated. The internal absorption ($\alpha_K = 0.27$) corresponds to values predicted by the theory according to Taylor & Mott. The absorption coefficient of the gamma radiation of $\lambda = 0.065$ A.U. was determined with Pt and found to be $\mu_{Pt} = 21$ cm.$^{-1}$ EF (11a)

Recovery of Electric Resistance and Hardness after Cold-Working in Zinc, Magnesium and Other Low-Melting Metals (Die Erholung des elektrischen Widerstandes und der Härte von der Kaltbearbeitung beim Zink, Magnesium und andern leichtschmelzenden Metallen). G. Tammann & K. L. Dreyer. *Annalen der Physik*, Series 5, Vol. 19, Apr. 1934, pages 680-688. Recovery from effects of cold-working occurs in Zn, (melting point 419° C.) and more so in metals with still lower melting point, below 20° C. These metals cannot, therefore, be hardened permanently by stretching, rolling and drawing, or these processes should be carried out at low temperatures, about —80° C. which is impractical. The temperature intervals within which recovery occurs was experimentally determined for wires of Zn, Pb, Sn, Cd, and Mg; the curves are reproduced. Ha (11a)

Ferrous (11b)

E. S. DAVENPORT, SECTION EDITOR

Steels for Heat-Treated Gearing. T. R. Rideout. *American Machinist*, Vol. 78, May 23, 1934, pages 376-379. **Gear Manufacturers Review Their Technical Progress.** *Steel*, Vol. 94, May 14, 1934, pages 50, 52. Report of the meeting of the American Gear Manufacturers Association, May 3-5, 1934. Includes 2-column abstract of paper by T. R. Rideout on steel for heat treated gearing. The selection of steels and the proper heat-treatment to develop the best properties with respect to hardness and tenacity are discussed; properties of alloy steels and hardness obtainable by case-hardening and full hardening are described and illustrated with curves. Ha + MS (11b)

What Is An Alloy Steel?—Survey of Opinions and Some Suggestions. Edwin F. Cone. *Iron Age*, Vol. 132, Sept. 14, 1933, pages 14-15, 70. Gives replies to letters submitted to several metallurgical authorities asking for a statement as to what constitutes an alloy steel together with a definition of an alloy steel as distinguished from plain C steels. Accompanying this was a list of selected steels concerning which there has been some difference of opinion, with request for "Yes" or "No" reply as to whether they are in alloy steel class. Greatest difference of opinion prevails regarding low-Cu steels (0.20 to 0.25% Cu) and high S and P types. Based on replies steels might be divided into (1) Plain C steels; (2) Special, general purpose steels; (3) Alloy steels. VSP (11b)

Coaxing Metal Strength. *Machine Design*, Vol. 6, Apr. 1934, page 27. Calls attention to experiments of J. B. Kommers on hot rolled pig Fe and brittle cast Fe which may be coaxed up to greater strength by the application of gradually increasing stresses. The strength of the former material has thus been increased as much as 24% and the latter by 33%. The same phenomenon was observed with notched specimens. WH (11b)

Alloys for Malleable Alloys. Rebecca Hall. *Iron Age*, Vol. 132, Dec. 21, 1933, pages 8-9, 60. An attempt to collect and summarize some of the information available on the effect of alloys in malleable Fe. The following elements have been investigated: Al, As, Bi, Bo, Ce, Cr, Co, Cu, La, Mo, Ni, Se, Te, Sn, Ti, W, U, V, Zn and Zr. VSP (11b)

Development of Cast Iron for Machine Construction. Oliver Smalley & W. W. Kerlin. *Iron Age*, Vol. 132, Oct. 19, 1933, pages 24-27. From a paper read before the American Society of Mechanical Engineers at Chicago. An outline of what constitutes cast Fe from the standpoint of chemical, structural and physical properties. VSP (11b)

Aluminum Alloyed Cast Iron (Ueber aluminiumlegiertes Gusseisen). E. Söhnchen. *Zeitschrift für die gesamte Giessereipraxis*, Vol. 55, Apr. 1, 1934, pages 137-139. Summarizes principal results of former investigations on effect of Al on properties of cast Fe. Results of recent investigations by Piwowarsky & Söhnchen are discussed. Special attention was given to obtaining sound test bars; to prevent Al_2O_3 from entering the mold a siphon-like gate was employed. Alloys with 10-20% Al are very sensitive to rapid cooling, but possess highest resistance to scaling. GN (11b)

Factors Affecting Performances of Tool Steel. A. J. Scheid, Jr. *Metal Progress*, Vol. 25, May 1934, pages 32-35 and 42. Discussion of the several grades of C tool steel available and their response to heat treatment. The effects of raw materials and of small amounts of such elements as Cr, W, V, Ni, Cu, Ti and Al are discussed. Ingot size and pouring temperature affect segregation. Reheating for forging or rolling, and annealing are operations that the steel maker must control. Selection, tool design and heat treatment are the factors which must be controlled by the tool maker. WLC (11b)

Niresist Cast Iron (Der Werkstoff Niresistgusseisen). Franz Roll. *Die Giesserei*, Vol. 21, Apr. 13, 1934, pages 152-156. The technique of producing Niresist is described in detail; it results from a mixture of pig-iron, ferrosilicon, ferromanganese and monel metal. The physical properties are described, corrosion resistance, magnetic behavior and wear resistance being outstanding. Alloys with more than 10% Ni and 5% Cu are non-magnetic. The extensive field of application in the form of crucibles, glass molds, valves, machinery parts, etc., is reviewed. Ha (11b)

Ferrocart, the Novel Magnetic Material (Ferrocart, der neue Magnetstoff). *Die Naturwissenschaften*, Vol. 22, Feb. 23, 1934, page 128. Refers to an invention of Hans Vogt who suspends magnetic particles of 5-20 μ diam. in a solution of a highly insulating material dissolved in a volatile solvent. Ferrocart has a permeability of 12 as compared with 3,000 for a solid Fe core. EF (11b)

Properties of Cast-iron Constituents. Oliver Smalley & W. W. Kerlin. *Mechanical World & Engineering Record*, Vol. 94, Dec. 15, 1933, pages 1196-1197. The nature and physical properties of constituent compounds of cast Fe are given together with a structural volume analysis and the physical properties of 4 different Fe's. Examples show why cast Fe's may be radically different, and how the mechanical properties of any casting are governed by the crystalline form of its constituents. Kz (11b)

Alloy Malleable Iron Excels in Strength and Wear Resistance. *Iron Age*, Vol. 131, June 22, 1933, page 992. See "High-Strength and Wear-Resistant Malleable Cast Iron," *Metals & Alloys*, Vol. 5, May 1934, page MA 226. VSP (11b)

American Progress in the Use of Alloys in Cast Iron. *Foundry Trade Journal*, Vol. 49, Aug. 10, 1933, page 84. Report of discussion of F. B. Coyle's paper (*Foundry Trade Journal*, July 6, 1933, page 7). See *Metals & Alloys*, Vol. 5, May 1934, page MA 225. OWE (11b)

Ignition Temperatures as Function of Size of Metallic Particles (Die Entzündungstemperaturen in Abhängigkeit von der Grösse der Metallteilchen). G. Tammann & W. Boehme. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 217, Apr. 7, 1934, pages 225-236. If metallic particles are conducted through a furnace small particles ignite and burn completely while larger particles simply oxidize and heat to a temperature not much higher than the furnace temperature. These conditions were investigated and formulas developed for several materials which give the ignition curves or ignition temperatures as a function of size of the particles. The temperatures increase hyperbolically with increasing size of section, the relationship for electrolytic Fe wire in air being 3.50/q, for Mn in air 15.5/q, for Mg in air 0.10/q, for Ce in air 2.25/q, (q being the section). Additions of Au, Ni, Si and Al to Fe increase the ignition temperature of small sections considerably, the effect being less for larger sections; this is due to the reduction of the oxide film on the Fe. Ha (11b)

Investigation of the Treatment of Steel for Permanent Magnets—Part II. R. L. Dowdell. *Transactions American Society for Metals*, Vol. 22, Jan. 1934, pages 19-30. Report of aging effects in 5 W steels, 0.53-0.76% C, 5.07-5.43% W; 3 Cr steels, 0.72-0.97% C, 2.16-2.87% Cr; 7 C steels, 0.54-1.18% C and 8 miscellaneous steels. Changes in magnetic properties over a period of 10 years are reported. Magnets showing the lowest percentage loss (14.8%) in magnetic induction for 8 years were treated by (1) magnetizing after hardening, (2) demagnetizing and tempering 12 hr. at 100° C., (3) remagnetizing and tempering at 100° C. until 5% magnetic induction was lost, and (4) sacrifice of 5% magnetic induction in reversed field. Results indicate that magnetic stability can be obtained by partial relief of both hardening and magnetic strains. Highest magnetic induction loss was found (35.1%) where magnetizing after hardening was the only treatment. Individual magnets usually lose their induction in the same sequence as groups. Percentage loss of induction on aging after different treatments is nearly constant for about 8 years if the sacrificed induction is taken into account. Discussion. WLC (11b)

BEARING steel must be clean steel, and by clean we mean just about the closest approach to the absolute in cleanliness that has been attained in steel-making. This is so important because, in steel of the extreme hardness used in bearings, the most minute inclusion may form the nucleus of a fracture.

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Iron-Tungsten-Cobalt Cutting Alloys. *Engineer*, Vol. 155, Apr. 7, 1933, page 348. From a paper read by W. P. Sykes before the American Society for Steel Treating and subsequently published in *Metal Progress*, Feb. 1933. See "The Cobalt-Tungsten System," *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 8. LFM (11b)

Phosphorus in Chromium Alloy Cast Irons. J. E. Hurst. *Iron Age*, Vol. 132, Sept. 7, 1933, pages 20-21. See "The Influence of Phosphorus on the Properties of Hardened and Tempered Cast Iron," *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 30. VSP (11b)

Alloy Steels in Industry. H. C. H. Carpenter. *Metallurgia*, Vol. 9, Apr. 1934, pages 175-178; *Heat Treating & Forging*, Vol. 20, May 1934, pages 227-232. Gives brief account of history and applications of the common alloy steels. JLG + MS (11b)

Thermal Conductivity of Irons and Steels and Some Other Metals in the Temperature Range 0° to 600° C. S. M. Shelton & W. H. Swanger. *Transactions American Society for Steel Treating*, Vol. 21, Dec. 1933, pages 1061-1078. Thermal conductivities over range 0°-600° C. of Zn, Ni, a few Ni alloys and 20 irons and steels selected as typical examples of commercial materials. Apparatus used was designed for comparative measurements eliminating calorimetric or power input measurement. Pb of high purity was used as standard and assumed to have a conductivity of 0.352 watts/cm./°C. Results are shown for the range covered at 100° C. intervals. For pure metals, irons and low alloy steels the thermal conductivities decrease with increase in temperature. The conductivities of high alloy steels and Ni alloys, such as 18-8 Cr-Ni steel and Ni-Cr alloys (chromel), increase with increasing temperature. Thermal conductivity appears as linear function of temperature in range investigated with exception of Ni which showed a sharp change from negative to positive temperature coefficient at temperature of magnetic transformation. Increasing amount of alloy in steel causes an increase in temperature coefficient, but generalizations regarding quantitative relationships of conductivity and alloy content cannot be made from these data. 24 references. WLC (11b)

Heat Treated Alloy Steels for Gears (Vergütungstahl als Werkstoff für Getrieberäder). R. Scherer. *Archiv für das Eisenhüttenwesen*, Vol. 7, Apr. 1934, pages 563-566. Data are given on tensile, impact, and bend tests of Cr, Cr-V, Cr-Mo, Cr-Ni, and Cr-Ni-Mo steels, quenched from a cyanide bath and tempered for use as gears. The most favorable combination of wear resistance, strength, and toughness was obtained in the Cr-Mo and Cr-V steels. The best tempering temperature appeared to be about 200° C. SE (11b)

Principles of Alloying Gray Castings with Metals (Grundsätliches zur Legierung des Graugusses mit Metallen). Franz Roll. *Die Giesserei*, Vol. 20, Sept. 8, 1933, pages 401-406. Discussion of what improvements in quality may be excepted from alloying metals with gray iron, the cost and whether or not the increase in price is justified by the improvement. Effect of metallic additions on the stability of iron carbide and on the eutectic and eutectoid points of the Fe-C system is discussed on the basis of affinity of the metals. Mg, B, Al, Si, P and some extent S, shift the eutectic point toward lower C concentrations. Ni, Cu and W slightly lower the C content of the eutectic. As and Ti have only a slight influence on the eutectic point; Co also seems to be without effect. An increase in the C content of the eutectic is caused by Mn, Cr and V. Metallurgical effects due to solubility of metals in ferrite influence toughness, uniformity, grain size, tensile strength, hardness. Ni, in particular, increases Brinell hardness; also Ti, Mo, W and Cu. If another carbide-forming element, such as Cr or V, is added a further strengthening of the material takes place, i.e., the mechanical properties are improved. The methods of adding metals in order to obtain most favorable effects are discussed. C, P and Si reduce shrinkage, Ni and Ti weakly so, while Cr, Mn, Al, Co and V increase shrinkage. Pb, Cd, Ag are not soluble in gray Fe; Cu and Bi to a limited extent. Ni increases the solubility of Cu in gray Fe. With respect to quenching at normal C contents it was found that 2 parts of Ni are equivalent to 1 part of Si, and 3 parts Ni are equivalent to 1 part C. When adding Cr the latter is equivalent to 1-2 parts of Ni, 2-4 parts Si. The melting point of the alloying materials added in the ladle should be as low as possible; for instance, for Ni and Cr a Ni-Cr-Fe-C alloy melting at about 1350° C., and for Mo, an alloy of 84% Mo melting at 1450° C. should be used. Ha (11b)

Osnabrück Compound Rails of the Klökner Works, Georgs-Marien Works in Osnabrück (Die Osnabrücker Verbundguss-Schienen der Klöckner-Werke A.-G., Abteilung Georgs-Marien-Werke in Osnabrück). M. Ros. *Materialprüfungsanstalt der Eidgenössischen Technische Hochschule Zürich*, Report 75, 32 pages. Results of laboratory and service tests, made in the years 1929-1931, on the compound steel rails of the Klöckner Works. In the rails the head is made of hard alloyed steel with a tensile strength of 110-145 kg./mm.² and a Brinell hardness of 300-400 while web and flange are made of softer steel with a tensile strength of 45-60 kg./mm.² and a Brinell hardness ranging from 125-170. The special features of the Osnabrück compound rails are: chemical purity of steel; uniformly fine grained structure; practical freedom from segregations; intimate and uniform blending of the special, high C steel of rail head with the softer steel of web and flange; high transverse strength and high resistance to deformation of flange; exceptional resistance to deformation under impact, both of head and flange in the tension region; extraordinarily high resistance to wear of head without special heat treatment. The rails offer no difficulty in machining, are easily welded and are less sensitive to mechanical and thermal influences due to braking than heat treated rails. The life of these compound rails, laid in places where stresses are heaviest and most unfavorable, such as in curves, at braking and starting sections and at points and crossings, is at least 4 times the life of railroad rails and 3-5 times the life of tramway rails made from basic Bessemer and open hearth steels. On straight sections the wear of compound rails is 6-7 times less. Owing to their exceptional mechanical properties and other practical advantages the Osnabrück compound rails are able to meet the most difficult service requirements especially with regard to resistance to wear and freedom from fracture. Their use yields an appreciable saving. GN (11b)

Wear Resistant VT Steel Rail of the Dortmund-Hörde Steel Company (Die Verschleissfeste VT-Stahl-Schiene der Dortmund-Hörder Hüttenerein Aktiengesellschaft Dortmund). M. Ros. *Materialprüfungsanstalt an der Eidgenössischen Technischen Hochschule Zürich*, Report No. 78, Oct. 1933, 22 pages. Results of extensive mechanical tests carried on during 1932/1933 are given. The steel used is a Mo and Si bearing C steel with very low amounts of P and S. It contains as further alloying constituents Cr, W, i.e., it is distinguished by elements that form double-carbides, and possesses eutectoid structure. The VT rail steel is characterized by cleanliness of structure, special cooling treatment and careful manufacture in which proper rolling temperature plays an important part. Average mechanical properties: Brinell hardness 305; proportional limit 48 kg./mm.²; yield point 62 kg./mm.²; tensile strength 105 kg./mm.²; elongation 8%; reduction of area 20%; resistance to alternating stress 42 kg./mm.² Machining offers no difficulties when using suitable tool steel. It can be welded by using appropriate material and process. VT steel rails meet the most stringent requirements as regards resistance to wear and safety from rupture under the heaviest train loads at highest speeds. Besides these technical advantages they possess notably longer life, thus greatly reducing costs of track maintenance and eliminating frequent interruptions to traffic. GN (11b)

EFFECT OF TEMPERATURE ON METALS & ALLOYS (12)

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

High-Temperature Steam Experience at Detroit. P. W. Thompson & R. M. Van Duzer. *Engineer*, Vol. 156, Dec. 22, 1933, pages 619-620. **Metals in High-Temperature Service at Detroit.** *Iron Age*, Vol. 132, Nov. 30, 1933, page 34. From paper read before the American Society of Mechanical Engineers, Dec. 1933. See *Metals & Alloys*, Vol. 5, May 1934, page MA 227. LFM + VSP (12)

Heat Resisting Alloys. L. J. Stanbery. *Metals & Alloys*, Vol. 4, Nov. 1933, page 175. Reply to discussion in Readers' Comment Column of his articles on this subject, *Metals & Alloys*, Vol. 4, Sept. 1933, pages 127-135; Oct. 1933, pages 159-164. WLC (12)

Development and Trend in Ferrous Alloys for High-Temperature Service. F. N. Speller. *Proceedings American Petroleum Institute*, Vol. 13 (III), 1932, pages 102-112. *Oil & Gas Journal*, Vol. 31, Feb. 16, 1933, pages 74-78, 26 references. Subject is discussed from the standpoint of tubular products suitable for temperatures above 400 deg. F. The present apparent trend is towards the wider use of alloy steels, especially of the 5% Cr type when dealing with corrosive crude oil. Carbon steel is still most generally used. W (1%) or Mo (0.5%) added to either of the above gives a moderate increase in resistance to creep, but actual value of these additions has not yet been definitely determined in general practice. The regular 18-8 Cr-Ni alloy is reported to have justified the higher initial expense in certain cracking-tube installations. The cause of intergranular corrosion of this alloy is now fairly well understood and two modifications of 18-8, acceptable for service up to 1300 or 1400 deg. F. are now available. Other Cr and Cr-Ni alloys are discussed and laboratory and service test data given. VVK (12)

Heat Resisting Alloys. W. B. Sullivan. *Metals & Alloys*, Vol. 4, Nov. 1933, page 174. Comment regarding and exceptions to some of the statements in *Metals & Alloys*, Vol. 4, Sept. 1933, pages 127-135. WLC (12)

Survey of the Magnetic Changes in Some Irons and Steels as a Function of the Temperature (Étude sur les changements magnétiques dans les fers et les aciers en fonction de la temperature). J. Seigle. *Journal de physique et le radium*, Vol. 5, Jan. 1934, pages 37-48. The reversible and irreversible magnetic transformations and their associated anomalies of expansion due to thermal treatment are summarized and the experimental results gained on ordinary soft steel, semi-hard steel with .22% C, hard plan C steel with .50-.60% C, 7 Ni—.15 C steel and 4 Cr — 1 Ni — .24 C steel are presented in diagrams. The interrelation of these anomalies and Curie points are discussed and X-ray findings are dealt with summarily. The experimenter arrives at the conclusion that β Fe consists of a mixture of α and δ Fe. EF (12)

Creep Testing of Metals—Part II. Elbert S. Rowland. *Mineral Industries, Pennsylvania State College*, Vol. 3, Apr. 1934, pages 3-4. General discussion. AHE (12)

Low Temperature Impact Strength of Some Normalized Low Alloy Steels. John J. Egan, Walter Crafts & A. B. Kinzel. *Transactions American Society for Steel Treating*, Vol. 21, Dec. 1933, pages 1136-1152. Low temperature properties of S.A.E. 1020-1090, 2335, 3135, 3140, 5130, 6120-6150 represented by 20 commercial samples and 15 laboratory prepared steels of low C with various single or double alloy additions such as Cr-Cu, Mo, Ni-Cu, Ni-V, V, Zr 0.15-0.66%, Mn-Zr, Cu-Zr, Ni-Zr, Mo-Zr, Ni-Mo, Mn-Mo, Mn-V and Armco iron are reported. Where Mn is given as an added alloy it is present in amount about 1.50%, in other cases less than 0.50%. Commercial prepared 3% Cr, cromasil, and 0.20% Z steels are included. Data lead to conclusions that common normalized low alloy steels are unsuited for engineering application below —100 C. though many are suitable down to —80 C. High impact resistance can be obtained with strength of less than 80,000 lb./sq. in. by combining a deoxiding or austenite forming element with a carbide forming element such as Cr-Cu, Ni-Cr, Ni-V, Ni-Cu, Zr, and V. Zr and V markedly improve the low temperature impact strength. Best properties are obtained with Cr-Cu combination, 0.83 and 0.53% respectively. See *Metals & Alloys*, Vol. 5, Apr. 1934, page MA 160. WLC (12)

The Action of Oxygen and Hydrogen Sulphide Upon Iron-Chromium Alloys at High Temperatures. R. L. Rickett & W. P. Wood. *Transactions American Society for Metals*, Vol. 22, Apr. 1934, pages 347-384. Alloys up to 28% Cr were studied in temperature range 760°-1095° C. (1400°-2000°F.) and exposure times up to 150 hr. Gain in weight was measured and chemical composition, microstructure and crystal structure of scales investigated. Addition of Cr above about 15% is without appreciable effect upon resistance tooxidation, increases below this, rapidly increase resistance. Scaling in H_2S is much greater and effect of Cr increase is less than in oxidizing conditions. Rate of scaling decreases with time and except in case of 28% Cr alloy increases rapidly with temperature up to 1090° C. (2000° F.). Increased resistance with higher Cr was accompanied by increased Cr in scale. Observations on the character of scale and consideration of other work support the hypothesis that reacting gas or higher products of reaction diffuse inward and metal or lower reaction products diffuse outward. This theory is in accord with effect of Cr content upon resistance and accounts for scale compositions. Time and temperature effects are consistent. WLC (12)

The Specific Heats of Beryllium, Germanium and Hafnium at Low Temperatures (Die spezifischen Warmen von Beryllium, Germanium und Hafnium bei tiefen Temperaturen). Silvia Christescu & Franz Simon. *Zeitschrift für physikalische Chemie*, Abt. B, Vol. 25, Apr. 1934, pages 273-282. The atomic heats at low temperatures of Be, Ge and Hf are presented graphically for the temperature range from 10° abs. to room temperature. All of the 3 elements show anomalous behavior. Ge exhibited the same type of anomaly as gray Sn, Si and C (diamond). The specific heat curve of Hf takes a course similar to that of ferro-magnetic substances. EF (12)

Heat Resisting Alloys. B. J. Sayles. *Metals & Alloys*, Vol. 4, Oct. 1933, page 165. Writer commenting on articles by Stanbery, *Metals & Alloys*, Vol. 4, Sept. 1933, pages 127-135, states that minor proportions of such elements as Mo, W, Si are of greater weight in the determination of high temperature service than either Ni or Cr. It is stated that the experience of the Calorizing Co. does not indicate the rate of creep as proportional to the fifth power of the unit stress in a short time tensile test. WLC (12)

Shafting Failure. L. W. Schuster. *Mechanical World & Engineering Record*, Vol. 94, Oct. 20, 1933, pages 1010-1011. Practical examples of failures are discussed. When steel is highly stressed in tension at an elevated temperature, liquid brass will enter into the grain boundaries. It was found that cracks were intergranular and had been set up by the entrance of molten brass from the bearing metal. The failure of a shaft made from an air-hardening Ni-Cr steel is traced to cracks resulting from heat treatment. The examples given show the need for properly selecting materials, suitable methods of manufacture, and careful maintenance. Ks (12)

CORROSION & WEAR (13)

V. V. KENDALL, SECTION EDITOR

Notes and Observations Concerning Gasoline and Heavy Oil Motors (Notes et Observations concernant les Moteurs à Essence et à huile lourde). H. RICARDO. *La Fonte,* Vol. 3, Oct.-Nov.-Dec. 1933, pages 378-380. **Corrosion Theory of Cylinder Wear.** *Automotive Industries,* Vol. 69, Aug. 5, 1933, pages 153-155. Discussion of a paper by Harry Ricardo presented at the 1933 meeting of the Institution of Automobile Engineers. The causes of cylinder wear and the trouble from cracking of the white-metal linings of crankpin bearings on high speed Diesel engines were discussed. Definite evidence showed that condensation in the cylinder was required to make the wear appreciable. It was suggested that corrosion was a bit overstressed as the cause of cylinder wear. A number of service tests showed that very considerable variations in wear may be effected by changes in piston design and cylinder material. In the latter case, by increasing the phosphorus content of the iron, the wear of the cylinder could be improved by 80 or 40%, but the major difference was in the larger area covered by the hard phosphite in the matrix of the iron. Wear was increased in a large degree by stopping and starting of the engine, and to even a greater extent when the engine became cold, between the stopping and starting. Chromium-plated bores improved the resistance to wear. The matter of corrosion vs. abrasion was thrashed out. DTR + FR (13)

Wear of Metals in Agricultural Machinery. E. A. SILVER. *Engineering Experiment Station News,* Ohio State University, Vol. 6, Apr. 1934, pages 19-20; *Heat Treating & Forging,* Vol. 20, May 1934, page 248. Service tests on plow shares are in progress. The problem is discussed, but no results are available as yet. Commercially available materials are being used. MS + HWG (13)

Behavior of Steel Tubes to the Action of Corrosive Agents (Ueber das Verhalten von Stahlröhren bei Einwirkung von aggressiven Stoffen). F. EISENSTECKEN. *Montanistische Rundschau,* Vol. 26, May 16, 1934, section *Stahlbau-Technik,* pages 1-3. See "Recent Investigations on the Behavior of Steel Tubes under Strong Corrosion Attack," *Metals & Alloys,* Vol. 4, Nov. 1933, page MA 344. BHS (13)

The Corrosion and Protection of Metals. ULICK R. EVANS. *Chemical Age,* London, Vol. 29, Nov. 11, 1933, pages 433-434. Summary of lecture before the "Treizième Congrés de Chimie Industrielle," Lille, France, Sept. 26, 1933. Review of films and protection by metallic and non-metallic coatings. 23 references. See also *Metals & Alloys,* Vol. 5, May 1934, page MA 231. VVK (13)

Corrosion Research on Light Metals. FREEMAN HORN. *Journal Society Chemical Industry,* Vol. 52, July 7, 1933, pages 554-562. See *Metals & Alloys,* Vol. 4, Dec. 1933, page MA 380. VVK (13)

How Effective Is a Cadmium Coating? J. S. HOFFMAN & L. J. GEORGE. *Steel,* Vol. 94, Apr. 30, 1934, pages 23-25. For effective protection against corrosion, minimum thickness of Cd plate should be 0.0002" for indoor exposure and 0.0004" for outdoor exposure. Lustrous deposit protects more efficiently than a dull finish. As the plate is never distributed absolutely evenly, it is important to know the minimum thickness. A chemical or stripping test has been developed which determines this minimum accurately. Two solutions (composition not stated) are used. Detailed directions are given. MS (13)

"MBV" Surface Treatment for Aluminum and Its Alloys. GUSTAV ECKERT. *Chemical Age,* London, Vol. 29, Oct. 7, 1933, Metallurgical Section, pages 23-24. See "The MBV-Process, an Effective Surface Protection for Aluminum and its Alloys," *Metals & Alloys,* Vol. 3, June 1932, page MA 162. VVK (13)

Influence of Oil in Soil Corrosion. WALTER F. ROGERS. *Proceedings American Petroleum Institute,* Vol. 13, (IV), 1932, pages 131-135. See *Metals & Alloys,* Vol. 5, Feb. 1934, page MA 39. VVK (13)

High Chromium Cast Iron for Smoke Resistance. RICHARD TULL. *Iron Age,* Vol. 131, June 15, 1933, page 952. Discusses the use of high Cr cast Fe to resist the corrosive effects of exhaust gas and steam from locomotives burning coal with a relatively high S content, and also the abrasive effect of hard particles carried in locomotive exhaust. Results show that losses on samples containing high Cr were practically the same for a 528 hr. test as they were for a 288 hr. period. High Cr cast Fe can be made in cupola by means of addition of Cr briquets to the charge. Though initial cost of 13% Cr cast Fe is higher than ordinary gray Fe, its life in service would be at least 500% that of ordinary Fe. VSP (13)

Problem of Corrosion Fatigue of /Metals (Die Frage der Korrosionsermüdung der Metalle). A. THUM & H. OCHS. *Forschungen & Fortschritte,* Vol. 9, Nov. 20, 1933, pages 478-479. Cylindrical test pieces submitted to alternating compression-tension tests withstand a breaking load which is only 1/3 of the ultimate tensile strength of ordinary pulling tests. In the presence of corroding agents a further strength reduction of 50% takes place. Fatigue tests on steels need not be extended over 10 million cycles but fractures still occur after 80 million cycles in corrosion fatigue tests. It is doubtful whether a safety limit against corrosion fatigue failure exists at all. Machinery parts exposed to the latter stress in service are pointed out. Effective protection against corrosion endurance failure is furnished by those materials which form an elastic impervious surface layer. Since failure is largely blamed on constant opening and closing of surface flaws, pores, etc., and consequent circulation of the corrosion agent in the metal surface, compressive stresses induced at the endangered surface have been applied with success. The beneficial effect of nitriding is also attributed to the occurrence of pre-stresses or "Druckvorspannungen." EF (13)

The Development and Application of a Practical Method of Electrical Protection for Pipe Lines Against Soil Corrosion. STARR THAYER. *Proceedings American Petroleum Institute,* Vol. 14 (IV), 1933, pages 143-152. Electrical currents on a pipe line cause metal to leave the pipe at points where the potential of the pipe is positive to that of the earth, i.e., where current passes off the pipe into the soil. If a potential difference can be introduced upon a transmission line so that the potential of the pipe is sufficiently lower than that of the adjacent soil, the pipe will be protected from all corrosive agents. Experience in laboratory and field tests, details of which are given, indicates that 0.3 volt difference is sufficient to stop corrosion. To create this potential difference without an excess of power cost, it is necessary to have a line protected with a high-resistance coating. It would not be practical to purchase the power necessary to introduce a potential of 0.3 volt on a bare line. Electrical protection can be applied economically and effectively to transmission lines having a high-resistance coating, such as coal-tar enamel, where such lines are found to need additional protection due to abrasions and imperfections in the coating. VVK (13)

Metals and Wines—Corrosion Resistance of Metals in Wine Making and Tolerance of Wines for Metals. H. E. SEARLE, F. L. LAQUE & R. H. DOHROW. *Industrial & Engineering Chemistry,* Vol. 26, June 1934, pages 617-627. The results of 403 corrosion tests of seven metals to wines while they were being processed in commercial equipment show that Inconel is adequate for all winery uses; Ni, monel metal, 18-8 alloy, Al, and Cu are useful in certain equipment; and Fe, Sn, and tinned metals have limited application. The tolerance of wines for metals was studied by adding metal citrates to three wines (125 samples) and noting the changes. Brilliance and possibly color were found to be affected before any changes of flavor and bouquet were noted. Only small quantities (3 mg. per liter) of Fe and Sn are required to induce objectionable changes of brilliance. Cu in much larger quantities has a slight effect on the brilliance of sweet red wine. None of the other metals affects brilliance. Al, Cu, and Cr have a slight though not serious effect on color. Ni and Zn have the least effect on color. 22 references. MEH (13)

The Maintenance of Oil Pipe Lines. WM. G. HELTZEL. *Proceedings American Petroleum Institute,* Vol. 14 (IV), 1933, pages 168-191. Pipe lines are subject to corrosion, leaking couplings, pulling of couplings, split joints and cracked welds. Corrosion may be caused by old oil leaks, natural soil corrosion, oil- or gas-field refuse, acids resulting from cinder fills, refinery waste, barnyard drainage, etc. decaying vegetation, artificial factors such as road crossings and railroad rights-of-way, and stray electrical currents from electric railroads or from other pipe lines. All of these factors are considered and the means and methods employed in maintaining pipe lines are discussed. Method of keeping records of such work is included. VVK (13)

Recent Investigations on the Behavior of Steel Tubes Under Strong Corrosion Attack (Neuere Untersuchungen über das Verhalten von Stahlrohren bei starker Beanspruchung durch agressive Stoffe). F. EISENSTECKEN & E. GEROLD. *Gas und Wasserfach,* Vol. 76, Dec. 30, 1933, page 934. Paper supplements the former papers of the authors on the problem in question (*Gas und Wasserfach,* Vol. 76, Feb. 4, 1933, pages 78-84, Feb. 11, 1933, pages 95-97, Mar. 25, 1933, pages 223-224. See *Metals & Alloys,* Vol. 4, Nov. 1933 pages MA 344). There are 3 methods of avoiding corrosion attack by stray currents (1) total insulation of the tube system including valves etc., (2) installation of insulating piece, insulating sockets etc. to decrease stray currents in pipe system to such an extent that they are no longer harmful, (3) arrangement of metallic joints to the electric conduits of tramways etc. This type of destruction is independent of the pipe material, cast Fe, Pb, Cu pipes were destroyed alike. GN (13)

Corrosion of Light Alloys (La corrosione delle leghe leggere). Part 2. G. GUZZONI. *Alluminio,* Vol. 3, Jan.-Feb. 1934, pages 3-12. Corrosion of various alloys by salt water spray has been studied. The author discards those methods of studying corrosion, such as the use of dilute HCl, which introduce conditions entirely foreign to any which the alloys ever undergo, and which give results of little practical value. The method above does not remove the protecting film of oxide, to which Al and its alloys owe their corrosion resistance. Test pieces, as for tensile tests, are suspended in a small chamber, and a spray of 20% salt solution, at 16-26° C, is passed through the chamber 10 hours a day. During the night, the samples are allowed to dry out, simulating actual weathering conditions. Three series of tests were made. First series, rustless steels, i.e., martensitic chrome steel, semi-ferritic chrome steel, 18-8 steel, and 18-8 steel with added V, 2nd series; anticorodal, avional, and aluman each heat treated as follows: semi-hard, hard, homogenized, and tempered. 3rd series: Lautal, and K. S. Seewasser; each, hardened and aged, coldworked, and hardened but not aged. The extent of corrosion was measured by the decrease in tensile strength and in elongation of the test pieces. Results: 1st series; the 18-8 austenitic steel was best, followed by, the semiferitic steel, and the martensitic chrome steel, poorest. 2nd, and 3rd series: Aluman and K.S. Seewasser showed very good resistance, while avional and lautal were poorer. Tempering (softening) these alloys reduces their resistance to corrosion markedly. Anticorodal is the only heat-treated alloy showing good resistance to corrosion. Here, again, the tempered sample shows the most corrosion. AWC (13)

Combating Corrosion of Production Equipment. STANLEY GILL. *Proceedings American Petroleum Institute,* Vol. 14 (IV), 1933, pages 43-48. The corrosion of oil well casing and tubing, sucker rods, working barrels, balls and seats, and lease tanks is discussed from the standpoint of materials economically available. VVK (13)

Experimental Methods for the Study of Corrosion. J. C. HUDSON. *Journal Society Chemical Industry,* Vol. 52, Mar. 24, 1933, pages 69T-75T. 34 references. Comprehensive literature review of the following corrosion testing methods. (A) Laboratory tests—(1) visual inspection, (2) oxygen absorption, (3) gain in weight, (4) potential measurements, (5) accelerated tests, (B) Field tests—(6) loss in weight, (7) gain in weight, (8) decrease in mechanical properties, (9) increase in electrical resistance. VVK (13)

Corrosion Tests on Weld Deposits. F. R. HENSEL & C. S. WILLIAMS. *Metals & Alloys,* Vol. 5, Jan. 1934, pages 11-16. An alternate-immersion type of corrosion test apparatus for determining the relative resistance of various types of weld metal is described. Preliminary tests on several standard materials were made to establish reproducibility of results. The cycle of the machine was one min. in and one min. out of the corrosive. The tensile strength of coated wire welds after subjection to normal HCl were still superior to the parent metal but the bare wire welds were so severely attacked that their strength was much less than the parent metal. Bare and dust coated wire welds were severely pitted and showed little general attack, the high grade coated rod showed more general attack. Microexamination showed that the thermal effects of welding to produce structural irregularity are of importance in determining the resistance of low carbon steel welds. WLC (13)

Effect of Methylalcohol on Magnesium, Aluminum and Their Alloys (Ueber den Einfluss von Methylalkohol auf Magnesium, Aluminium und ihre Legierungen). J. FORMANEK. *Automobiltechnische Zeitschrift,* Vol. 37, Apr. 10, 1934, pages 190-192. Perfectly pure, water-free methanol does not affect alloys of Mg and Al, Mn, and of Cu, Si and Fe, while water-free methylalcohol produced by distillation of wood and also synthetic methylalcohol cause a violent complete disintegration of Mg-Al alloys and gradual disintegration of Cu-Si-Fe alloy. Pure Mg is not attacked. Addition of water-free ethylalcohol to water-free methylalcohol, as long as the latter is not present in excess, does not disintegrate the before-named alloys; an excess however causes slow disintegration. Pure Al and its alloys lautal, silumin and hydronalium are not at all attacked by methylalcohol. These facts are important for application of these materials in automobile and airplane construction. Ha (13)

Resisting HCl Corrosion with Metals. F. A. ROHRMAN. *Chemical & Metallurgical Engineering,* Vol. 40, Dec. 1933, pages 646-647. Only the following metals are suitable under certain conditions: Durichlor, Hastelloy A & C, Monel Metal and Nickel. Ni and Monel resist dilute solutions if hydrogen depolarizers are absent. Hastelloy A, 58% Ni, 20% Mo, 20%Fe, 2% Mn, resists all concentrations in the absence of O_2 or oxidizing agents. Hastelloy C, 58% Ni, 17% Mo, 6% Fe, 14% Cr, 5% W, resists all concentrations even in the presence of oxygen and oxidizing agents. Both alloys have good physical properties and are machinable. The corrosion rate shows a maximum at the lower concentrations of HCl. Durichlor, 81% Fe, 14.5% Si, 3.5% Mo, 1% Ni, is very resistant, depending upon a porous grey surface film, in the absence of which the corrosion rate is high. PRK (13)

Corrosion of the Threads of Oil Well Tubing is a Particularly Vicious Form of Attack. WALTER F. ROGERS. *Oil & Gas Journal,* Vol. 32, May 25, 1933, pages 61, 64. Midyear Meeting American Petroleum Institute, May 1933. Records are kept of the failures which occur to tubing in service in a large number of wells. Results of the records show that the most common failures occur in the joint ends either from corrosion back of the threads, thread breaks, or split joints. Corrosive attack of the threads is a particularly vicious form of attack, and is obtained both on plain-end tubing and on short test sections. Its relation to mill scale is being studied. Joint-end failures and split welds can largely be overcome by the use of external-upset seamless tubing, although for best results and surety of freedom from attack from ring-worm corrosion this material should be fully normalized. Galvanized tubing has been found to suffer from end-joint failure, and the best results will probably come from using galvanized external-upset seamless steel where extremely corrosive conditions prevail. VVK (13)

Earthing Electrodes. T. C. GILBERT. *Electrical Review,* Vol. 113, Dec. 22, 1933, pages 870-871. Includes citation of investigation of Cu stranded conductors used as earthing conductors on an a.c. distribution system. These had been buried in coke-breeze. On examination a year later, considerable corrosion was found to have taken place, and in one instance a 0.0775 in.^{2} conductor had disappeared. Sections in clay were unaffected. Trouble may be due to chemical causes, as coke often contains NH_3. MS (13)

Corrosion Fatigue and Protective Coatings. F. N. SPELLER & I. B. MCCORKLE. *Proceedings American Petroleum Institute,* Vol. 14, (IV) Oct. 1933, pages 24-28; *Oil & Gas Journal,* Vol. 32, Oct. 26, 1933, pages 73-74; *Oil Weekly,* Vol. 72, Jan. 1, 1934, pages 16-20. To determine the relative value of organic coatings in prolonging the useful life of ferrous materials subjected to corrosion fatigue, eight types of "paints" or "varnishes" adapted to application by spraying, dipping, or brushing were applied to corrosion fatigue specimens. The method of testing comprised: (a) static-corrosion tests in a solution representing a typical corrosive oil well water (22, 5 and 3 thousand p.p.m. of sodium chloride, calcium chloride, and magnesium chloride respectively, saturated with hydrogen sulphide and natural gas—oxygen being absent) to determine the resistance of the coating to attack and penetration of moisture and (b) corrosion-fatigue tests in the solution to study the deleterious effect of repetition of strain on the coating and to get some estimate of the increased life due to the protection afforded by these coatings. Preliminary results indicate the following conclusions (a) Paint films definitely increase the life of metal subject to corrosion fatigue. Without any coating the specimen usually failed in less than one-fourth the time under the same condition. (b) The protective power of the coating is liable to be greatly diminished under cyclic strain. Kz + VVK (13)

Corrosion Problems in Ice Plants (Beitrag zur Korrosionsfrage in Eiserzeugern) ALBRECHT STEINBACH. *Zeitschrift für die gesamte Kälteindustrie,* Vol. 40, July 1933, pages 104-108, Aug. 1933, pages 128-130. Paper before the Deutscher Kälteverein Leipzig, 1933, reports on extensive corrosion tests performed in the Research Laboratory of the Gesellschaft für Lindes Eismaschinen A.G. Wiesbaden. Corrosion resistant materials utilized in the ice industry were tested individually and in combination in $CaCl_2$, $MgCl_2$ and chromate solutions. The losses in g./m^2 are given in 6 diagrams referring to testing times of 500 days max. The order of merit with reference to a 16% $CaCl_2$ solution is Pb coated Fe (best), cast Fe, bronze, galvanized Fe. Among the combinations, Pb coated Fe/unprotected sheet Fe stood up best. This also held true if other substances were present in the corroding liquid. The couple galvanized Fe/unprotected sheet Fe is very unstable in $CaCl_2$, $MgCl_2$ and other freezing solutions on the market. It has been definitely established that the highly protected materials or the highly passive or noble surfaces and coatings (18/8, parkerized steel, paint coated materials) endanger other unprotected structural members connected with them in the same proportion as they are protected themselves. Corrosion tests on individual materials are consequently of little use since they do not correspond to actual service conditions. Measurement of the current intensity of combinations between 2 or more metallic parts furnishes incomplete knowledge since this external circuit does not include the corrosive action of local elements. Chromate solutions proved to be less aggressive than the customary solutions of technical $CaCl_2$ and $MgCl_2$. EF (13)

Cause and Prevention of Calcium Sulphate Scale in Steam Boilers. FRED. G. STRAUB. *University of Illinois Bulletin,* Vol. 30, No. 8, Oct. 24, 1933, pages 3-75. Cause and prevention of embrittlement in steel boilers in relation to concentration of sulphate in the boiler water was investigated. Methods of testing, chemical reactions going on in the boiler water and behavior of boilers under different pressures are discussed at length. The presence of more than 30 parts per million (1.7 grains per gallon) of sodium carbonate in the boiler water will prevent formation of calcium sulphate scale up to 2000 lbs./in.^{2} pressure. The carbonate content necessary to prevent sulphate scale is independent of sulphate concentration within the limits of concentrations carried in the average high-pressure boiler. Ha (13)

A Review of Recent Progress in Mitigating Soil Corrosion. GORDON N. SCOTT. *Proceedings American Petroleum Institute,* Vol. 14 (IV), 1933, pages 130-142. 58 references. This report covers the developments and improvements in pipe-protection practice since the formation of the Institute's corrosion committee in 1928 which have resulted in a direct saving to the industry and an indirect saving to every consumer of oil, gas or water. These developments are (1) recognition of importance of proper application of coatings; (2) discovery of soil stress; (3) classification of coatings as to behavior through nation-wide tests of protective coatings; (4) development of methods of examining coatings; (5) introduction of ways of forecasting corrosive effects of soils; and (6) the better understanding of the phenomenon of pitting in relation to the properties of the soil, the time and surface extent of exposure. Future improvement may be anticipated through (1) metallurgy; (2) improved use of present materials; (3) standardization of tests on protective coatings; (4) development of a routine procedure for soil-corrosion surveys; (5) the further study of the effects of corrosion, especially with reference to the relation between test data and field experience; (6) cathodic protection; and (7) better application of economic principles. All of these activities or fields for study should be focused upon the preparation of a comprehensive manual on pipe protection. VVK (13)

Corrosion Following Water Purification Processes. CHESTER A. SMITH. *Journal American Water Works Association,* Vol. 25, June 1933, pages 818-821. Water previously treated should be maintained at a pH of 7.5 to 8.5 and should be just saturated with calcium carbonate for the prevention or retardation of corrosion. In general the addition of lime has been found to be the most efficient and economical method of retarding corrosion. VVK (13)

Elimination of Silica in Boiler Feed Water (La Silice des Eaux d'Alimentation des Chaudières et son Elimination). ROBERT STUFFER. *Chaleur et Industrie,* Vol. 14, Apr. 1933, pages 169-177. It is first pointed out that scale coatings containing more than 20% SiO_2 cause bursting of boiler tubes even when thickness of coating does not exceed 0.5 mm. Two methods are available for preventing scale formation (1) Elimination of SiO_2 contained in water by resorting to a suitable process. (2) Physico-chemical treatment of water. FR (13)

Relative Corrodibility of Some Common Metals and Alloys. JEROME STRAUSS. *Metal Progress,* Vol. 24, Nov. 1933, page 41. Tabulation sheet of corrosion losses of commercial materials in various media. Compositions are given. WLC (13)

Report of Subcommittee VI on Atmospheric Corrosion of Non-Ferrous Metals and Alloys (Report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys.) WM. H. FINKELDEY, *Chairman. Proceedings American Society Testing Materials,* Vol. 33, Pt. I, 1933, pages 234-251. This report presents the results of the atmospheric corrosion tests on 24 non-ferrous metals and alloys after an exposure of approximately one year at each of 9 test locations. The amount of corrosion was measured by (1) determining change in weight on duplicate 9 x 12 in. plate specimens (2) tension tests to find the change in tensile strength and percentage elongation and (3) visual examination of the 9 x 12 in. plates from each of the 9 test locations to determine the amount and character of the corrosion product films on the surface of the specimens. The data are presented in the form of tables with no conclusions being drawn. VVK (13)

Special Alloys for Working Barrels and Balls and Seats. WALTER F. ROGERS. *Proceedings American Petroleum Institute,* Vol. 14 (IV), 1933, pages 51-57. Many pumping wells are equipped with a sucker-rod actuated pumping system composed of a common working barrel and a cup-packed traveling valve. The frequent changes of barrels and cups necessary to keep the pumping system in working condition is a major portion of the total lifting cost. An 18-8 Cr-Ni steel-lined composite working barrel showed a much longer life than the regular barrel. For balls and seats, stainless steel was found to be the most satisfactory type. Specially-hardened K-Monel-metal can be used to advantage in relatively shallow wells. Nitrided material will sometimes give good service, but it cannot be used under all conditions. Cyclops 17-A was deserving of further tests. Chromium plated material was excellent from the standpoint of corrosion resistance but failed due to defects in the coating application. VVK (13)

Effect of Chemical Treatment of Well Fluid on Tubing Corrosion. WALTER F. ROGERS. *Preprint Mid-Year Meeting, American Petroleum Institute, Production Division*, May 1934, 5 pages. Certain investigators have shown that alkaline treatments can be used to stop the attack of corrosive fluids on ferrous materials, with particular application to the protection of city water mains by the deposition of a calcium carbonate protective-scale layer. It has also been reported that alkaline treatments have been used with success to reduce corrosion of sub-surface equipment in oil wells producing fluid containing hydrogen sulphide. A series of tests was run on three wells at Goose Creek, Texas, and two wells in the Smackover, Ark., pool to test the value of the treatment. These wells produced fluid of varying degrees of corrosivity, but were all free from hydrogen-sulphide gas. Sodium hydroxide and sodium carbonate were added periodically and results evaluated by following the frequency of tubing failure before and during the treatment. The author did not find any benefit accruing from the treatment.
VVK (13)

Use of Non-rusting Steels and Alloy Cast Irons in the Chemical Industry (Verwendungsmöglichkeiten von nichtrostenden Stählen und Gusseisenlegierungen in der chemischen Industrie). ERNST BLAU. *Chemiker-Zeitung*, Vol. 57, Dec. 20. 1933, pages 999-1000. 13 to 25% Cr and Cr-Ni steels have been used extensively for construction parts in the chemical industry. The Cr-Ni steels can be worked better and have better corrosion resistance than the Cr steels. Recently much 18% Cr-8% Ni steel has been used for beer barrels and milk cans. The addition of Mo improves the resistance to H_2SO_4, sulphite liquors in cellulose manufacture, and acetic acid. Practical tests are the best for choosing the correct alloy, 18% Si cast iron, called Thermisilid, has good corrosion resistance. The shapes of the castings in which it is used must be simple, as it is difficult to cast. It is used for kettles, retorts, tubes, etc. 13% Cr iron castings are also used. 34% Cr iron castings are resistant to HCl, H_3PO_4, H_2SO_4, acetic and lactic acids.
CEM (13)

Corrosion Effects of Lubricants Upon Bearing Surfaces. CHRISTOPHER H. BIERBAUM. *Iron Age*, Vol. 132, Aug. 31, 1933, pages 20-21, 58. Describes investigations conducted on chemical effect of additions to mineral oils, that is, their effect on bearing surfaces, their selective corrosion upon these surfaces and their possible effects upon "running in." Results show that pure light colored mineral lubricants seem to have no corrosive action on bright metal surfaces. Pure fatty acids are more or less corrosive upon ordinary metals and subjecting them to oxidation, increases their corrosive effects. Flowers of S can readily be dissolved in mineral lubricating oils and is one of the most corrosive constitutents that has been added to lubricating oils. S should never exceed a slight trace. Saponified oil in pure anhydrous condition showed no chemical action upon a Cu-Sn bronze, but after absorbing moisture it had a selective corrosive effect.
VSP (13)

Magnesium Alloy Protection by Selenium and Other Coating Processes. Part II. G. D. BENGOUGH & L. WHITBY. *Engineering*, Vol. 136, Oct 6, 1933, page 399; *Metal Industry, London*, Vol. 44, Jan. 5, 1934, pages 3-5; Jan. 19, 1934, pages 83-85. See *Metals & Alloys*, Vol. 5, May 1934, page MA 231.
Ha + LFM (13)

Wool Fat as Rust Preventer (Wollfett als Rostschutzmittel). FREITAG. *Apparatebau*, Vol. 45, Nov. 24, 1933, pages 141-142. Wool fat dissolved in $CCl_2.CHCl$ is a suitable means for providing Fe parts with a corrosion protective that can be removed easily when no longer required. Corrosion experiments on wool fat—protected Fe parts gave favorable results even under severe corrosion attack.
GN (13)

Monel Metal and Pure Nickel: Their Properties with Reference to Chemical Plant. *Chemical Age*, London, Vol. 28, Mar. 4, 1933, Metallurgical Section, pages 15-16. General information on corrosion resistance based on manufacturer's bulletin. VVK (13)

Corrosion, Protection of Metals and Alloying (Korrosion, Metallschutz und Metallveredelung). WALTER SAVELSBERG. *Chemiker-Zeitung*, Vol. 57, Nov. 8, 1933, pages 883-885. The electrochemical theory of corrosion, electrolytic solution potentials and passivity are discussed. Oxides usually have better resistance against corrosion than the corresponding metals. Cu is an exception. Oxides are used extensively as paint pigments to protect metals. To be effective paints must stick well to the metal and be free from porosity. If a harder and more heat resistant protective coating is needed vitreous enamel is used. It must be able to withstand shocks and temperature changes. Metallic coatings are cheaper and quicker to apply. Sn, Zn, or Pb, applied by hot dipping, are satisfactory for low temperature service. For heat resistance Al, applied hot, and Ni or Cr applied by plating, are used. Cd plating protects against corrosion even when the coating is not perfect. Sherardizing sticks to metal better than plating. "Alitizing" is a similar process using Al. No protective coatings last indefinitely against corrosion. If permanent results are desired alloying the metals should be resorted to, such as alloying steel with 18% Cr and 8% Ni. CEM (13)

Cathodic Protection of Pipe Lines. W. R. SCHNEIDER. *Gas Age-Record*, Vol. 71, Apr. 8, 1933, pages 355-359, 366. Distribution Conference American Gas Association, Apr. 1933. Cathodic protection has been employed on the pipe lines of the Pacific Gas & Electric Co. since Jan. 1930. Earth current surveys locate positive portions of pipe lines showing a discharge of current greater than 1 milliamp./sq.ft. of pipe surface and test coupons are buried in the soil adjacent to the pipe. Reliability of indication of corrosion is determined by placing coupons at different distances from the pipe and comparing loss in weight with one placed in contact with pipe surface. Discharging pipes are usually found at salt water crossings in reclaimed tide lands, in crossings through the beds of salt lakes and in irrigated lands. Cathodic protection is applied by placing an auxiliary electrode or "pilot pipe" at distance of 100 times the diameter of the main, or more, from the main line. Current is drawn from the main line and caused to discharge from the "pilot pipe." Length of pipe that can be protected 'y given installation varies with diameter of pipe, resistance of pipe per unit length, combined resistance of pipe wrappings and surrounding soil which is called the "leakage resistance." Details and illustrations are given. VVK (13)

Dissolution of Metals in Acids (Über die Auflösung von Metallen in Säuren). MARIA SCHUNKERT. *Zeitschrift für physikalische Chemie*, Abt.A, Vol. 167, Dec. 1933, pages 19-28. Additions of albumin, agar, gelatine, gum arabic, casein, starch, and saponin reduce the dissolution speed of Fe and Zn in concentrated and dilute acids. The strong electrolytes methyl violet and methylene blue decrease the dissolution speed of Fe in concentrated H_2SO_4 and increase the dissolution of Zn in diluted H_2SO_4. The rate is directly proportional to their adsorption power. The additions are deposited on the dissolving metal but not on its contaminations. Strongly dissociated salts accelerate the dissolution velocity in some cases. In others the reaction is inhibited. This behavior is ascribed to dissociation changes. If the dissociation increases (dilute solutions) the current intensity in the local elements rises and thus the amount of metal going into solution. If the dissociation of one component has been checked by certain additions, the solution process can be retarded since the undissociated molecule is absorbed to a greater extent. EF (13)

Destruction of Material by Cavitation (Werkstoffzerstörung bei Kavitation). H. SCHROETER. *Zeitschrift Verein deutscher Ingenieure*, Vol. 78, Mar. 17, 1934, pages 349-351. A preliminary report on tests made in the Walchen power station with nozzles in the water turbines. Several steels were tried, they showed a clear dependence of cavitation and erosion on Brinell hardness. Pretreatment was of great importance. It seems that, besides hardness, rigidity and elasticity of the parts building up the nozzles, are of influence. The erosion as loss of material, is given in diagrams; the tests are continued. Ha (13)

Rapid Development of Patina on Copper after Installation. JOHN R. FREEMAN & PHILIP H. KIRBY. *Metals & Alloys*, Vol. 5, Apr. 1934, pages 67-70. Method of producing jade-green patina on copper installations by use of spraying with intermediate drying, using a solution of 90 lb. ammonium sulphate, 3 lb. copper sulphate, 1¼ lb. concentrated ammonia in 110 gal. of water, is described. High humidity conditions, heavy dews, application so that solution stands in small droplets followed by drying accelerate the formation of the patina. WLC (13)

Solubility of Copper in Water as Regards the Application of this Metal in Pipe Line Construction (Beiträge zur Wasserlöslichkeit des Kupfers im Hinblick auf die Verwendung dieses Metalls im Wasserleitungsbau.) VICTOR FROBOESE. *Gas und Wasserfach*, Vol. 77, Apr. 14, 1934, pages 225-231. Report from the Hygienic Laboratory of the Reichsgesundheitsamt, Berlin. Tasting tests were made on water from Cu pipe lines. The solubility of Cu in distilled and pipe line water with variable content of O and CO_2 was investigated. It was found that the CO_2 content of the water determines the degree of solubility of Cu. From the tests described and the ratio of solubility of CuO and Cu_2O in H_2O containing CO_2, it results that the protective stable layer in Cu pipes is not formed by Cu_2O. CuO compounds must be formed when the Cu content of the H_2O is low. In using Cu pipes it is desirable, as regards freedom of H_2O from Cu, to have the lowest possible content of free CO_2 with medium O content and at least a medium carbonate hardness of the H_2O. GN (13)

Corrosion of Metals in Salt Solutions and Seawater. G. D. BENGOUGH. *Journal Society Chemical Industy*, Vol. 52, Mar. 10, 1933, pages 195-210; Mar. 17, 1933, pages 228-239. Methods of measuring corrosion may be grouped in 3 classes: (1) tests under actual working conditions, industrial tests (2) tests in conditions believed to be similar to but not actually industrial conditions, field tests and (3) laboratory tests. The justification of laboratory tests is that in them we can ascertain the factors which actually control corrosion rates. A corrosion testing apparatus designed for the quantitative periodic measurement of the oxygen absorbed and hydrogen evolved in the process under controlled conditions of temperature and pressure is described in detail. In standardizing the apparatus the influence of the following factors, illustrated with curves, is considered: preparation of the surface, method of suspension of specimen, surface area and shape of specimen, depth of immersion, cross section of vessel, volume of liquid used, stability of apparatus, temperature and oxygen pressure. Author's definition of an accelerated corrosion test is "one which reproduces the corrosion-time curve characteristic of any given metal in standard conditions, with the time-scale suitably expanded." Distribution of corrosion on steel and zinc seems to be dictated by (1) distribution of films of corrosion products possessing protective properties which might be either long-continued (with steel) or ephemeral (with zinc) (2) tendency of alkali to creep away from its principal seat of formation (at and near the water-line) down into the interior of the liquid, and so cause protection there (3) special reactivity of edges, at which corrosion started and then spread inwards at varying rates; spreading could take place towards either more, equally, or less aerated parts of the metal and (4) the tendency of heavy metallic salt to fall, and so to neutralize alkali and cause corrosion to spread downwards from a given starting point. Author considers that whenever oxygen appears to produce local passivity at highly differentially aerated places, the effect is really due to a secondary, film-forming action, which is dependent on the nature of the solution and the conditions of immersion. He therefore suggests the abandonment of the differential aeration principle of local action and pitting as a useful general statement, and substitute for it a "film distribution in view" of corrosion. VVK (13)

Investigation of the Suitability of Various Kinds of Wire for Use in Sieves (Untersuchungen über de Eignung verschiedener Drahtsorten bei Verwendung in Aufbereitungssieben). E. DIEPSCHLAG & E. KÖRNER. *Metallwirtschaft*, Vol. 13, Mar. 30, 1934, pages 224-226. Drum-shaped sieves were made, using strands of 12 different kinds of steel wire in each sieve. The individual wires were weighed and measured for thickness before and after use for sieving coke, basalt and ore on a production scale, to determine their wear resistance. The 12.4% Mn steel, with 390 Brinell hardness, had the best wear resistance. In general the stronger and harder higher C steel wires wore better than the softer and weaker lower C steel wires. CEM (13)

Mitigating Internal Corrosion of Natural Gas Lines. A. B. ALLYNE. *Gas Age-Record*, Vol. 72, Nov. 11, 1933, pages 463-464. Part of report of the 1933 Transmission Pipe Line Committee of the Pacific Coast Gas Association. The internal corrosion of high pressure natural gas lines is becoming a serious problem in California, practically all of the major fields being involved. Cause of corrosion is largely due to H_2S and O in the presence of condensed water vapor. More rapid and accurate methods of detecting corrosive gas constituents are needed and are being developed at the present time. Closer control should be kept on the O entering pipe lines This is the duty of gasoline and oil companies supplying natural gas. Where O is present in natural gas it can be reduced by stopping of leaks in vacuum-collected gathering systems or elimination of tank vapors. Possibility of taking tank vapors at a slight pressure instead of at a vacuum should be investigated. Dehumidification of natural gas appears to be the most practical method of preventing internal corrosion. Six methods are described. VVK (13)

Chemically Resistant Iron and Steel Alloys (Die chemisch beständigen Eisen- und Stahllegierungen). W. ACKERMANN. *Chemiker-Zeitung*, Vol. 57, Nov. 15, 1933, pages 901-903. Data on resistance to corrosion against various reagents and resistance to scaling are given for low C, 13% Cr and for 18% Cr, 8% Ni steels, free machining stainless steels containing S up to .35% or Zr or Se additions, valve steels for operating temperatures up to 900° C. with Si and W additions, and Ni-Resist cast iron. CEM (13)

Corrosion Tests of Screws in Aluminum Alloys (Korrosionsversuche mit Schrauben in Aluminum-Legierungen.) H. BAUERMEISTER. *Zeitschrift für Metallkunde*, Vol. 26, Feb. 1934, pages 34-37. The corrosion of screws of brass, phosphorbronze, and iron imbedded in the cast alloys Silumin and KS-Seewasser, in alternate immersion in sea water and sea air, in sea water and in sea air, was studied; the effect of oil on the corrosion was noted. Exposures were from 4 to 169 days. The extent of corrosion was determined by the possibility of removing the set screw from the Al alloy. Brass is the most suitable screw material (of those studied); phosphor-bronze is entirely unsuitable; iron is midway. No difference could be noted between Silumin and KS-Seewasser; oiling helps in the removal of the screw. RFM (13)

Influence of Impurities upon the Corrosion of Zinc (Einfluss von Verunreinigungen auf die Korrosion von Zink.) O. BAUER & P. ZUNKER. *Zeitschrift für Metallkunde*, Vol. 25, Nov. 1933, pages 282-284. An experimental study of the loss of weight of Zn strips prepared from zinc "E" (0.015% Pb; 0.002% Fe, 0.001% Cu) by the addition of Pb and from zinc "R" (1.12% Pb; 0.11% Cd; 0.03% Fe; 0.002% Cu) by the addition of Cd, Cu, Sb, and Fe. The alloys in strip form were immersed in a 1% aqueous solution of NaCl and removed from time to time to determine weight loss. Similar determinations were made in 0.10N HCl by measurement of rate of H evolution. The data are dependent upon the ratio of metal surface to volume of solution, probably because of the effect of O concentration. Zinc E and zinc R have about the same corrosion in 1% NaCl solution, and also in 0.01N HCl. All added metals increase the rate of corrosion, both in NaCl and HCl solutions; these data are shown in graphs. RFM (13)

Effect on Copper, Nickel, and Copper-Nickel Alloys of Washing and Bleaching Materials (Das Verhalten von Kupfer Nickel, und Kupfernickel-Legierungen gegenüber dem Angriff von Wasch-und Bleichmitteln). O. Bauer & H. Arndt. *Metallwirtschaft*, Vol. 13, Apr. 6, 1934, pages 241-245. Sheets of pure Cu, Cu-Ni alloy containing 48.8% Ni, Nicorros containing 66.13% Ni, Monel metal, and pure Ni in the hot rolled, annealed, and cold worked condition were immersed in solutions of 8 washing and 2 bleaching materials. The tests were made at room temperature for 300 days and at 75°C. for 50 days and the loss in weight of the samples was determined. The washing solutions were 1%, the commercial bleaching compound solution .5%, and the chlorinated lime solution .25%. The preliminary treatment of the metals had no effect on their corrosion resistance. The corrosive attack at 75° was greater in all cases than at room temperature. Pure Cu was considerably attacked by the soap, one of the commercial washing materials, soda ash + perborate, and soda ash solutions, and very strongly by the two bleaching solutions. The perborate, soap + perborate, and the other two commercial washing material solutions had very little effect on pure Cu. The Cu-Ni alloys and pure Ni were attacked very slightly by the 8 washing solutions, but were strongly attacked by the two bleaching solutions containing Cl. With few exceptions the amount of corrosion decreased with increase in Ni content. CEM (13)

Defects of Boiler Tubes near Their Joint Seams with the Front Sheet (Ausbiegungen von Flammrohren in der Nähe der Verbindungsnähte mit dem vorderen Boden. Kurze Haltbarkeit von Krempenschweissungen). *Zeitschrift des bayerischen Revisionsvereins*, Vol. 37, 1933, Dec. 31, 1933, pages 240-242. In the particular case reported defect described was due to corrosion occurrences. GN (13)

Deterioration of Structures in Sea Water. *Iron & Coal Trades Review*, Vol. 128, May 4, 1934, page 715. Extracts from the 14th (interim) report of the Committee of Institution of Civil Engineers state that iron and steel bars exposed for 10 years suffered an average loss in weight which was double that of the corresponding 5-year set; some alloy steels suffered less. Ni and Cr steels and cast irons were deteriorated more severely under alternate wet and dry conditions. Cu steels showed peculiar behavior; whereas in the 5-year test the 2% Cu steel was slightly superior to that containing 0.6% Cu the reverse was observed in the 10-year test. 36% Ni steel was the best preserved material, free from pitting. Cr steel displayed serious pitting while cast irons, though they lost little in weight, showed some internal corrosion upon fracture. A set of bars exposed to air for 10 years in Colombo was more seriously corroded than the sets exposed elsewhere; a thick layer of rust covered most of them; even high Ni and Cr steels were slightly roughened. The definite report with conclusions will soon be published. Ha (13)

Corrosion-Resisting Materials. *Iron & Coal Trades Review*, Vol. 128, May 4, 1934, page 719. Large pickling tanks are built of a new material "Ka Be" of which tiles, bricks, etc., are made; composition is not given, it is acid resisting and attacked only by hydrofluoric acid. Ha (13)

OCTOBER ISSUE CLOSES EARLY
ADVERTISERS IN OCTOBER
Should Send in Copy and Cuts by September 12
(instead of September 25)

APPLICATIONS OF METALS & ALLOYS (14)

Materials Choice Cuts Weight, Stops Corrosion. HENRY T. SCOTT. *Machine Design*, Vol. 6, Apr. 1934, pages 15-18. Pertains to problems involved in selecting proper materials for an automatic machine for bottling milk in paper containers. By utilizing a Mg alloy (cast) the former weight of a rotating spider for instance has been reduced from 1127 lbs. to 562 lbs. Except for the bottle filling unit all parts that come in contact with food are made of 18/8 and those members not likely to be splashed with food are made of 14% Cr steel. A special Cu-Pb-Fe-Ni-Mn-Zn alloy was developed for the filling mechanism to insure easy disassembling, high pressure steam cleaning corrosion resistance and a permanent high polish. Early corrosion difficulties with glue rolls made of brass were overcome by stainless steel rolls whose ends are burnished and work hardened to prevent galling. WH (14)

Metals Gleam Forth. H. L. ROBERTSHAW. *Textile World*, Vol. 84, May 1934, page 99. Metal yarns are used in textiles; their preparation for weaving and the weaving process are briefly discussed. Ha (14)

Avoiding Stress Concentration by Using Less Material. R. V. BAUD. *Product Engineering*, Vol. 5, May 1934, pages 170-172. It is shown that by giving material proper shape a piece of lesser weight will often be better with respect to stress distribution and maximum stress value than one containing more material but of theoretically worse design. Several examples illustrate this fact which is simply a practical application of the law that the stress is inversely proportional to the distance of the stress direction line from the surface. Ha (14)

New Light Weight Italian Coaches. *Railway Engineer*, Vol. 55, Jan. 1934, pages 13-15. Describes and illustrates new vehicles of the Italian State Railways which are steel-framed but incorporate Al wherever possible. The sides are made of Cu-bearing steel sheets. WH (14)

Non-Ferrous (14a)

G. L. CRAIG, SECTION EDITOR

A New Way of Making Nickel Parts. G. HAMPRECHT & L. SCHLECHT. *Engineering Progress*, Vol. 15, May 1934, pages 96-97. See "New Process for Commercial Production of Nickel," *Metals & Alloys*, Vol. 4, Dec. 1933, page MA 377. Ha (14a)

Ten Years of Aluminum Light Construction of American Railroad and Street Cars (Zehn Jahre Aluminium-Leichtbau an amerikanischen Eisen-und Strassenbahnwagen). THEOBALD. *Glasers Annalen*, Vol. 114, Feb. 1, 1934, pages 21-22. Historical survey on the application of Al for car construction in U. S. A. GN (14a)

34 General Meeting of the Schiffbautechnische Gesellschaft (34. Hauptversammlung der Schiffbautechnischen Gesellschaft). TEUBERT. *Schiffbau, Schiffahrt & Hafenbau*, Vol. 34, Dec. 15, 1933, pages 425-441. Among others, 3 metallurgical or allied papers are presented at the 34 General Meeting of the Schiffbautechnische Gesellschaft, Hamburg. Schimmel reporting on "Experiences on the Behavior of Copper-Nickel Alloys and Aluminum Brass against Seawater" states that the latter may entirely replace the former due to equal seawater corrosion resistance but lower price. The destruction of natural protective films is stressed. Cavitation between metal and liquid causes a "hammering" effect of the latter. In Al bearing brass the injured film heals due to continuous formation of Al_2O_3. Tube corrosion underwent marked changes since higher boiler water speeds were employed. Schmidt speaking on "Hydronalium," an Al alloy with 5-15% Mg + Mn, Si, Zn, states that castings are coated by adding protective substances such as boric acid to the mold sand. Physical properties given: tensile strength = 55-60 kg./mm.^{2}, yield point = 45-50 kg./mm.^{2}, elongation 15-10%. No seawater corrosion has been noticed on a yacht made almost entirely of Mg-bearing Al alloys after 18 months' service. Lacher speaking on the "Needle Principle in Heat Transfer and its Utilization in Ship Building with Special Reference to Light Metal Constructions" points out the greater efficiency of pointed heating areas as compared with ribs. A further advance has been achieved by utilizing light metal as needle preheater material for boiler water preheaters and exhaust gas heaters in connection with Diesel engines. WH (14a)

Lead Bronze in Automobile and Aircraft Motor Construction (Nochmals: Bleibronzen im Automobil-und Flugzeugbau). ERICH SEMMLER. *Deutsche Motorzeitschrift*, Vol. 10, Sept. 1933, page 178. Controversy between Armbruster (See *DeutscheMotorzeitschrift*, Vol. 10, Aug. 1933, pages 156-160) and author (See *Metals & Alloys*, Vol. 5, Jan. 1934, page MA 14 1-R). Semmler claims the superiority of Pb bronzes over white metal bearings under a surface load of 200 kg./cm.^{2} and at 3 atm. oil pressure. The oil temperature rose to only 70°C. while the hardened and ground steel shaft showed 95°C. at the region of maximum pressure. Under the same testing conditions, a newly ground steel shaft exhibited 105°-114°C. Semmler states that the hardness of Pb bronzes has been recently reduced substantially. He furthermore denies that a diffusion takes place between the bearing metal and its carrier. EF (14a)

Use of Aluminum in Automobile Construction (Die Verwendung von Aluminium im Kraftfahrzeugbau). R. STERNER-RAINER. *Automobiltechnische Zeitschrift*, Vol. 37, Apr. 25, 1934, pages 220-223. Al and its alloys find very wide use in the manufacture of automobiles and aeroplanes. A list of ordinary Al alloys, high-grade refined Al alloys and corrosion-resistant Al alloys is given containing composition, state in which employed, heat treatment and manufacturer. Examples of chassis, motor housings, pistons, wheels, are illustrated. Of particular importance are the Cu- and Si-containing piston alloys of which a list of compositions used in different countries is given. Ha (14a)

Powder Metallurgy as Illustrated by Tungsten. W. P. SYKES. *Metal Progress*, Vol. 25, Mar. 1934, pages 24-29. Highly refractory character of W and the necessity for high purity preclude its production by a melting process. Its reduction is effected from purified WO_3 in a current of H_2 at 1500°F., powder metal thus obtained screened and after combinations of suitable sizes pressed under 20 tons/in.^{2}, pressed bars sintered in a resistance furnace at 2400° F. in H_2, this is followed by treating or running about 95% of the current necessary to melt the section through it for 15 min. The material is then ready for reduction by hot swaging to a diameter of 0.100" at which size it is ready for drawing through carbide dies to sizes desired. Control of grain size in the finished W filament is attained by proper selection of size of powder and by the use of certain impurities introduced into the WO_3 before reduction whose oxides act as centers of crystallization holding down the size. The production of oilless bearing or metallic sponges by powder methods is briefly discussed. WLC (14a)

The Féry-Carbone "dry" tin accumulator. C. J. V. FÉRY. *Technical Publications of the International Tin Research & Development Council*, London, Series C, No. 1, Apr. 1934, 5 pages. An accumulator that can be handled like a primary dry cell has been designed and is in commercial production in France in which the lead of a lead/H_2SO_4/lead peroxide cell is replaced by tin and the acid is absorbed in a granular ceramic packing. The cell discharges from about 1.9 down to about 1.6 volts, does not gas on discharge or on storage, has low internal resistance, and is lighter than an equivalent lead cell. It is said to be suitable for flash-light batteries. From the statements made, it would appear that it should have good shelf life. Details of performance and a discussion of the chemical reactions are promised for later publication. HWG (14a)

Aluminum for Struts and Wire. FEDERICO GIOLITTI. *Metal Progress*, Vol. 24, Nov. 1933, pages 48, 59. Compressive strengths are reported for Bondur and Alclad alloys and application to struts and transmission lines of Al alloys discussed. WLC (14a)

Ferrous (14b)

M. GENSAMER, SECTION EDITOR

Steel Houses for the Tropics (Stahlhäuser für die Tropen). *Montanistische Rundschau*, Vol. 26, May 16, 1934 (Section *Stahlbau-Technik*), page 7. Describes a steel dwelling built especially for use in tropical climates, exhibited at the last Leipzig fair. BHS (14b)

Five-Room Residence Is 90 Per Cent Rolled Steel. *Steel*, Vol. 94, May 21, 1934, pages 28, 30. Describes house which will be exhibited at "A Century of Progress," 1934. Essentially it is like the one shown in 1933. Panel method of construction is retained. New design includes use of steel for some of the interior walls and partitions, studs and ceilings. Total weight of steel is about 25,000 lbs. MS (14b)

West Coast Steel House Uses Cellular-Type Wall Units. *Steel*, Vol. 94, June 4, 1934, pages 30, 49. Describes a house the outstanding feature of which is that all load-bearing walls are of welded, cellular steel construction and are embedded in a concrete slab which is used as a floor or foundation. Withstands earthquake, wind, and vermin hazards. Roof trusses also are of steel. MS (14b)

Low-Cost Steel House Offers New Features in Design. *Steel*, Vol. 94, April 9, 1934, pages 37-38. Describes house which incorporates air-cell principle, radiant walls, Zeppelin-type floors, and unified air control. Steel used throughout for columns, walls, trim, doors, and floor spans is 20-gage sheets. Floor channels are 14-gage. Structural angles are used for foundation base. Slightly more than 9 tons of steel are required. Intended for shop fabrication. MS (14b)

Galvanized Steel Frame Used in New House Construction. *Steel*, Vol. 94, May 14, 1934, pages 30, 32. Describes new type of framing. Structural members are fabricated from galvanized steel sheets and for the most part are fastened together by galvanized steel bolts and nuts. Wherever possible framing is cut out for lightness and for accommodating utility lines. Corners of door jambs and trim are welded. MS (14b)

Shop Fabricated Steel House Utilizes 11 Tons of Steel. *Steel*, Vol. 94, Apr. 2, 1934, page 30. Describes house in which a frameless double-strength system is used. Exterior siding is of ingot-Fe, formed in a trough-shaped section. Floor and roof are of cellular sheet-steel construction. MS (14b)

Develops Insulated Steel Frame for House Building. *Steel*, Vol. 94, April 16, 1934, pages 30, 32. Describes new system of framing. Standard section consists of 2 light channels separated with a layer of insulation and securely tied together with steel pins. Tie channels are welded to the studs. Standard angle connections are used to tie together all corners, angles and junctions of walls and partitions. Rafter connections are of the hinge type. MS (14b)

From Poles to Piling. *Steel*, Vol. 94, June 4, 1934, pages 25-26. Fluted steel tubes for lighting standards are transformed into shells for cast-in-place, concrete piles, by arc welding a pointed steel nose to the driving end and a steel collar to the butt end. MS (14b)

Turbine Blading Materials. SYDNEY D. SCORER. *Electrical Review*, Vol. 113, Dec. 1, 1933, pages 764-765. Factors to be considered in the selection of blading materials are stress conditions, and effects of corrosion, erosion and high temperature. Steel alloys and Cu alloys are generally used. Mn and P bronzes are satisfactory up to 500°-600° F. An alloy containing 85% Cu and 15% Ni is also satisfactory and may be used up to 650° F. when the blade speed is moderate. Within recent years, monel metal has been finding extensive use. At present, one of the most widely used materials in England is a steel containing 4-5% Ni, 0.3% Mn, 0.5% W, 0.02% P, etc. It is used for blades subjected to high temperatures in the high-pressure stages of turbines and is satisfactory in most sections when chemically pure steam is used. Stainless steel and iron with 10-13% Cr and 0.5% Ni are also very popular. MS (14b)

Unusual Applications of Stainless Alloys. C. C. SNYDER. *Iron Age*, Vol. 131, June 8, 1933, pages 895-896. Careful analysis of fabricating problems often discloses the feasibility of adopting stainless alloys. Gives a number of examples. Initial cost in many instances is greater for stainless, but added life of equipment and reduced maintenance costs result in substantial savings. VSP (14b)

Road Guards Offer Market for Steel in Millions of Tons. A. J. HAIN. *Steel*, Vol. 94, Apr. 16, 1934, pages 27-29, 40. Discusses prospects for steel road guards and outlines principal designs, particularly of plate guards. MS (14b)

High Speed Railway Cars Pioneer New Fields for Stainless. EDWARD G. BUDD. *Steel*, Vol. 94, Apr. 9, 1934, pages 23-26, 49. Railroad cars constructed of stainless steel by the shotweld process weigh ⅓ as much as an ordinary car but possess equal strength. Stainless steel makes closed sections practical. Other fields are shipbuilding and bridge construction. MS (14b)

Fabricating the Water Gates for Boulder Canyon Project. C. C. BRITON. *Iron Age*, Vol. 132, Oct. 18, 1933, pages 10-13, 72. Each lower gate valve weighs 240,000 lb. and each upper gate valve 150,000 lb. A fabricated and welded structure was selected. VSP (14b)

Iron Wire for Stapling Shoe Soles, its Application and Standards. V. N. TZVETKOV & I. O. DEMBO. *Izvestiya Tzentralnogo Nauchno-Issledovatelskogo Instituta Kozhevennoi Promuishlennosti*, Apr. 1932, pages 7-11. In Russian. The breaking strength of wires containing 0.11-0.82% C, 0.40-0.75% Mn, traces of Cr and 0.20% Si was investigated. Tentative standards are given. AAB (14b)

Better Automobiles Mean Better Metallurgy. ERNEST E. THUM. *Metal Progress*, Vol. 25, Feb. 1934, pages 15-21. One of reasons for delay in automobile production this year was the necessity to go into the helical spring production for the new types of wheel suspension. Production of heavy coil springs is discussed. Other automotive developments in gears, cast crank and cam shafts, brake drums, bearings and use of stainless steel instead of chromium plate are discussed and the part of the metallurgist in these developments. WLC (14b)

Rustless Steels in the German Brewing Industry. M. H. SOMMER. *Iron Age*, Vol. 131, June 22, 1933, pages 984-987. Discusses use of rustless steel by the German brewers for barrels, fermentation vats, storage and railroad tanks, yeast pans, etc. 18-8 type of steel is used. Includes in tabulated form tests conducted on resistance of various metals to corrosive chemicals. VSP (14b)

Service Conditions Control Permissible Stress. C. R. SODERBERG. *Machine Design*, Vol. 5, Feb. 1933, pages 27-31. Criticizes that the mechanical strength of machinery parts is defined against the background of an arbitrary testing method. In a few cases the conditions of the test happen to agree rather closely with the conditions of service. Discusses the fundamental aspects of the problem of strength and safety of machine parts under these viewpoints: (a) factor of safety and utilization of strength, (b) ductile materials under variable stress, (c) same under steady stress, (d) brittle materials. Until further information is available it appears safe to predict failure on the basis of the maximum shear theory. In the case of variable stress the question of finish may assume real importance. There are cases where unmachined specimens have shown 50% lower strength than polished specimens of the same material. This influence appears to be greater for alloy steels than for C steels. Under combined stress, the brittle materials may be treated by the maximum-stress theory. The ultimate strength in compression is often much greater than for tension (cast iron). Discusses the aspects of the problem of failure at elevated temperatures. 12 references. WH (14b)

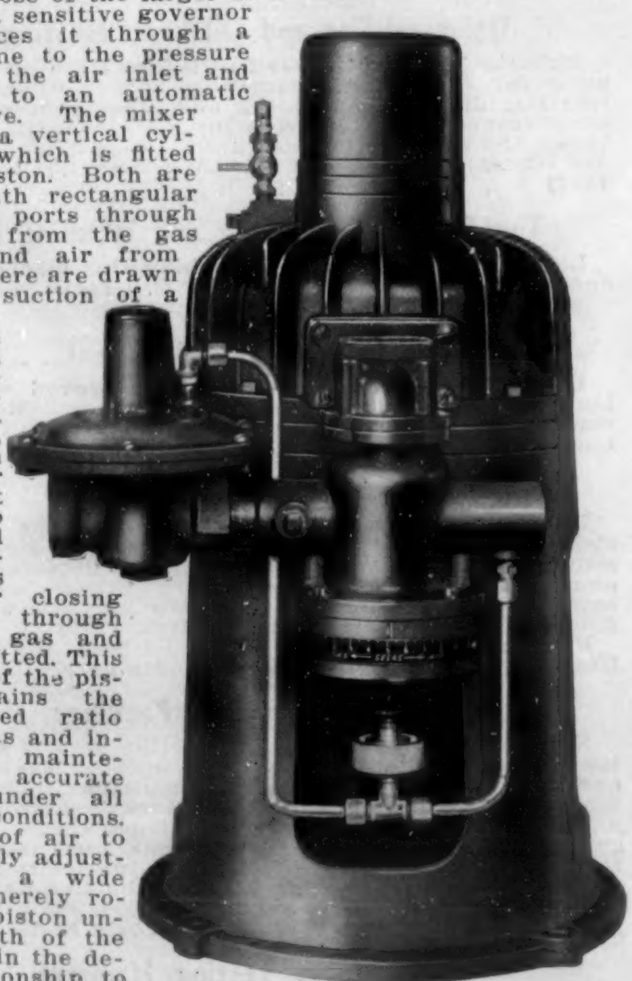
NEW EQUIPMENT and MATERIALS

New Plastic Insulating Refractory

The Chicago Fire Brick Company, Chicago, Illinois, has developed a new plastic insulating refractory which is to be marketed under the trade name PIRE. This insulating plastic is claimed to be particularly adaptable for use in intermittent furnaces where actual operating temperatures do not exceed 2500° F. The insulating properties reflect the heat, giving a flash heat to the walls in a much shorter period of time and thereby saving both fuel and labor due to the greatly shortened preheating period. PIRE is not used to back up regular fire brick but is used in its place and has the faculty of being able to stand up under flame impingement. Because of its monolithic character heat loss by leakage is retarded. The material has practically no coefficient of expansion. It is light in weight, weighing approximately one-half of an ordinary fire brick after having been thoroughly burned in the furnace.

Combustion Controller

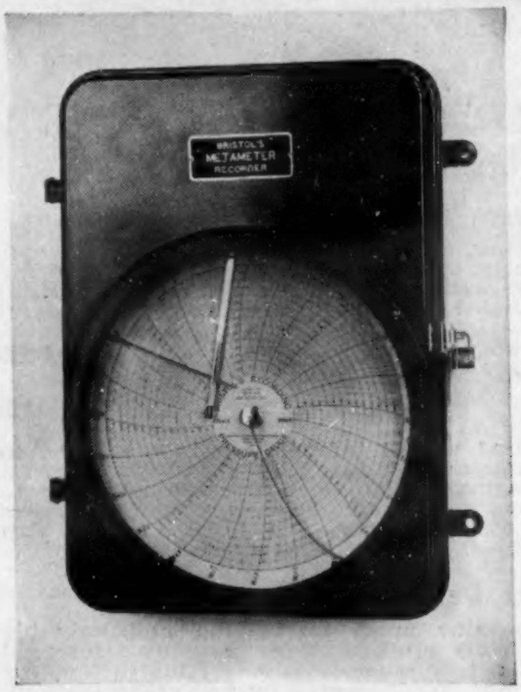
This combustion controller developed by the Selas Company, Philadelphia, Pa., affords the industrial user of gas a device for controlling the most delicate combustion apparatus. The operating principles of the Selasette are similar to those of the larger Selas machines. Gas is taken in through a sensitive governor which reduces it through a balancing line to the pressure existing at the air inlet and delivers it to an automatic mixing valve. The mixer consists of a vertical cylinder into which is fitted a sliding piston. Both are provided with rectangular gas and air ports through which gas from the gas governor and air from the atmosphere are drawn in by the suction of a compressor. The position of the piston is automatically controlled by a diaphragm, which raises or lowers it according to the demand on the machine, thus opening or closing the ports through which the gas and air are admitted. This movement of the piston maintains the predetermined ratio of air to gas and insures the maintenance of accurate mixtures under all operating conditions. The ratio of air to gas is readily adjustable over a wide range by merely rotating the piston until the width of the air port is in the desired relationship to the width of the gas port. This adjustable air-gas ratio provides remarkable flexibility and allows the machine to be used for mixing any desired kind of gas in any required proportions.



From the mixer the mixed gas is drawn through a check valve into a constant speed compressor which delivers it under pressure to the outlet. A sensitive diaphragm-operated pressure governor maintains the discharge pressure constant irrespective of the demand. By varying the amount of weight on the pressure governor, mixture pressure up to 2 pounds per square inch can be obtained. The compressor is driven by a ¼ h.p. totally enclosed ball bearing motor especially developed for this machine. The Selasette has a maximum capacity of 650 cubic feet of air-gas mixture per hour at atmospheric pressure, is capable of continuously delivering the mixture at a maximum pressure of 2 lbs./in.^{2} and has a mixing range on manufactured gas from 1 : 1 up to complete mixture, and on butane from 1 : 2 up to complete mixture. It can be adapted to mix 2 gases in any desired ratio and will maintain a constant mixture ratio throughout the entire capacity range up to 650 ft.^{3}/hr. When conditions require the use of an air-gas mixing valve for use with a high pressure compressor or turbo blower the Selasette gas governor, mixer and check valve can be furnished as a unit without the compressor. It is then provided with a ¾" outlet connection. The compressor, motor, check valve and pressure governor can also be furnished without the mixing unit when service conditions call for an efficient and reliable gas compressor with a capacity up to 650 ft.^{3}/hr. at a maximum of 2 lbs. outlet pressure.

Metameter System for Telemetering

The Bristol Company of Waterbury, Conn., has now available a novel long distance transmitter and recorder operating on the well known chrono-flo system. Adapted to Bristol's Metameter, this system consists of a transmitter, a recording receiver, a relay and rectifier box at the receiver, and a two wire line connecting the transmitter and receiver. With this system, records of temperature, pressure, liquid level or motion may be transmitted great distances, 250 miles or more, with extreme accuracy and with freedom from circuit disturbances. The principle of operation is as follows: The transmitting element detects the measurement and translates it into a time function. By this means, the two wire circuit carries an impulse during a portion of a fixed time interval and is broken for the remainder of the interval. This time interval is provided by a synchronous motor-driven continuously-rotating cam. The time that the circuit is made during each rotation of the cam is proportional to the amount the condition being measured has risen above the base to zero measurement. Conversely, the duration of contact off is proportional to the amount the condition has dropped below the maximum amount. These messages of circuit made and circuit broken are translated by the recording receiver into upward or downward movement of a pen positioning mechanism, thereby periodically carrying the pen arm to its new position as measured by the transmitter. This system requires a source of alternating current at both receiver and transmitter, but they need not be synchronized, nor of the same frequency. The recording receiver uses a 12" chart and is housed in the new moisture proof rectangular case.



New Welding Electrode Coating

The Rich Manufacturing Co., Ltd., Los Angeles, Calif., announce they are using a new process to produce the flux mantle on their welding electrodes which prevents segregation of the various fluxing elements. It is claimed this coating permits making a dense weld deposit with fine grain structure and increased resistance to wear and corrosion. Undercutting along the edges of the weld seam is prevented, the arc is greatly stabilized and loss of welding material incurred by sputtering, is reduced. Electrodes can be furnished for carbon and alloy steels including stainless; cast iron; monel metal; copper alloys; and heat, acid and wear resisting alloys.

Production Spray Gun

A new type of spray gun is announced by the H. D. B. Corporation, 900 N. Spaulding Ave., Chicago, Ill., called H. D. B. No. 5 Spray Gun. This instrument, it is stated, leaves no orange peel effect on the work and reduces material costs appreciably. One of its features is the new type of nozzle head which produces highly atomized break-up of material at reduced forward speed of spray.

MANUFACTURERS' LITERATURE

R-S Gate Valves

Bulletin No. 8 sets forth full information about the R-S line of Gate Valves. Illustrations, line drawings, tables of dimensions. R-S Products Corporation, Germantown Ave. at Wayne Junction, Philadelphia, Pa. (312)

Sly Tumbling Mills

Bulletin No. S-73 illustrates and describes these tumbling mills designed for low cost cleaning. 8 pages. The W. W. Sly Mfg. Co., 4700 Train Avenue, Cleveland, Ohio. (313)

Simplified Welding

Leaflet illustrating and describing the Hobart heavy-duty 40 volt "Simplified" Arc Welder. Hobart Bros. Box DN 281, Troy, Ohio. (314)

Pyro-Mortar

Leaflet containing interesting and useful data on Pyro-Mortar, a superior dry refractory cement. Illustrations. Directions for using. Quigley Company, Inc. 56 West 45th Street, New York, N. Y. (315)

The Lectrodryer "Activated Alumina System"

Pamphlet illustrating and describing this system which completely or partially dries air and gases, its uses being controlled atmosphere annealing of deoxidized sheet—Bright annealing, etc., dehumidification of warehouses and special process rooms, industrial and chemical processes, gas conditioning. Pittsburgh Lectrodryer Corp., P. O. Box 1008, Pittsburgh, Pa. (316)

Durox

Much interesting and useful information is contained in a little pamphlet setting forth full data on Durox-S-20, an outstanding metallurgical development proven superior to all other known alloys now available for abrasion-resisting service. Enterprise Foundry Corp., 2902-19th street, San Francisco, Calif. (317)

Sperry Detector Equipment

Bulletin No. 56 contains much interesting and valuable data on this rail testing equipment for detecting internal defects in used rails before re-laying. Illustrations of typical flaws that cannot be discovered by any other method, plan of Sperry Detector Equipment installation. Sperry Rail Service (Division of Sperry Products, Inc.) Sperry Building, Manhattan Bridge Plaza, Brooklyn, N. Y. (318)

Mesta

Handsome brochure within the pages of which may be found a brief description and some illustrations of the plant and products of Mesta Machine Company who for a number of years have been designers and builders of machinery used in the iron and steel industry. 127 pages. A valuable addition to any library. Mesta Machine Company, Oliver Building, Pittsburgh, Pa. (319)

Swartwout Industrial Ovens

Catalog No. 31 contains much information on Swartwout Industrial Ovens and accessory equipment for Japan, enamel, paint and lacquer drying, armature and insulating varnish baking, lithographing, ceramic drying, rubber curing, low temperature heat treating, chemical drying and other manufacturing processes requiring temperatures up to nine hundred degrees Fahrenheit. Sectional drawings, charts, illustrations, table of dimensions, 48 pages. Foundry Equipment Company, (Swartwout Oven Division), Cleveland, Ohio. (320)

New Duriron Bulletin No. 172

Bulletin, just off the press, on centrifugal pumps for acids and alkalies, covering a new series of pumps just brought out and gives the general construction. Separate inserts will be issued on each pump giving the capacities, dimensions and rating charts. Included in the general bulletin is a brief analysis of the different corrosion-resisting alloys in which the pumps are procurable. The Duriron Co., Dayton, Ohio. (321)

Riverside Beryllium Copper

Pamphlet announcing this heat treatable copper alloy in sheet, strip, wire and rod. Information on composition, general properties, hardness, electrical conductivity, thermal conductivity, density, annealing, heat treatment, data on tests, etc. Also list of suggested applications. The Riverside Metal Company, Riverside (Burlington County) N. J. (322)

Potentiometer Stabilog

Bulletin No. 194 contains full information regarding this new temperature controller which gives completely automatic, full floating control on all ranges and in all conditions found in commercial processes. Illustrated. The Foxboro Company, Foxboro, Mass. (323)

Alcoa Aluminum Screw Machine Products

Full information on these products is contained in an attractive folder, fully indexed. Illustrations, diagrams, tables of dimensions of American National threads, American National Coarse-Thread Series, American National Fine-Thread Series, Dimensions of Rough and Semi-finished square and hexagon Machine and Tap bolt heads, Finished Hexagon Cap Screw Heads, etc. Also contained is information on S.M.P. Bolts, S.M.P. Chicago Binding Screws, Stove Bolts, Burrs, S.M.P. Nuts, S.M.P. Machine Screws, S.M.P. Wood Screws and S.M.P. Specialties. Aluminum Company of America, Pittsburgh, Pa. (324)

Brown Pyrometers

Catalog 15B illustrates and describes the Millivoltmeter type of pyrometer for indicating, recording, controlling, multiple recording and multiple controlling. Schematic diagrams, temperature charts. 48 pages. The Brown Instrument Company, Philadelphia, Pa. (325)

Silicon Alloy Sheets for Electrical Apparatus

Third revised edition of an attractive booklet on this subject for the laminated structure of transformers, generators, motors and other electrical apparatus. Gauge tables, tables showing maximum total losses of electrical sheets, iron loss curves. 34 pages. American Sheet and Tin Plate Company, Frick Building, Pittsburgh, Pa. (326)

Keeping Tab of Boiler Temperatures With "Alnor" Pyrometers

Leaflet illustrating and describing these pyrometers, heavy duty wall type and portable which meet all boiler room requirements. Illinois Testing Laboratories, Inc., 149 W. Austin Avenue, Chicago, Ill. (327)

Universal Gas and Oil Fired Heating Units

Bulletin No. H-104 gives full information on these heating units for Japanning, enameling, core baking, drying, heat treating, drawing, annealing and other processes, requiring temperatures from 100 deg. up to 1200 deg. F. Sectional views of Universal heating units. Industrial Gas Engineering Company, Inc., 201 E. Ohio Street, Chicago, Illinois. (328)

The Greene Quenching and Washing Machine

Leaflet illustrating and describing this machine, which insures high grade hardening. E. G. Greene, 1503 University Road, Cleveland, Ohio. (329)

Perm-A-Color Solvent

Leaflet containing full data on improved solvent cleaning for metals in Rex solvent machines. Illustrations of machines. Rex Products & Mfg. Co., 13005 Hillview Avenue, Detroit, Mich. (330)

Misco "C"

Leaflet containing data on Misco "C," the corrosion resistant alloy for digester neck rings, digester bottom sleeves, blow-off valves, acid valves, digester heads, acid pumps, bottom crosses, strainers, fittings and all other equipment exposed to corrosion by sulphite acids. Michigan Steel Casting Co., Detroit, Mich. (331)

Published by the same firm, Bulletin No. 3A. "Misco High Temperature Alloy Sheet Containers."

Johns-Manville Packings

New Catalog containing information on J-M packing service, rod and plunger packings, braided packings, rubber and duck packing, flax and jute packings, piston packings, moulded packing cups, pump valves, asbestos rope, wick and cord, groove packings, sheet packings, gaskets and gasketing tapes, packing recommendations, packing instructions, packing lubrication, use of lubricating seal rings, gasketing instructions, packing symbols, weights of packaging packings, other Johns-Manville materials. Johns-Manville, 22 East 40th Street, New York, N. Y. (332)

Hardness Testing Hammer

Leaflet describing Type P testing hammer, its application, and instructions for use. Steel City Testing Laboratory, 8843 Livernois Ave., Detroit, Mich. (333)

Case Histories in Product Design

Interesting treatise by T. J. Maloney of the New Jersey Zinc Co. and George Switzer, Product Designer, outlining the life stories of three products, who originated them, who designed them, how they sold, plus the probable reasons for their success or failure. Profusely illustrated. New Jersey Zinc Co., 160 Front Street, New York, N. Y. (334)

Thermalloy X-Ray

Bulletin 200 contains interesting data on this inspection service for alloy heat-resisting castings. Radiographs, illustrations. The Electro Alloys Co., Elyria, Ohio. (335)

Standard Furnaces for the Heat Treatment of Steel

Bulletin No. 26 contains data on Standard Large Oven Furnaces, table of sizes and dimensions, construction details. Bulletin No. 27 contains data on Pot Furnaces, tables of inside dimensions of pots, general specifications. Bulletin No. 28 contains data on Small Oven Furnaces for tool steel, annealing, pre-heating and drawing. Tables of sizes and specifications. Standard Fuel Engineering Co., 667 Post Avenue, South, Detroit, Mich. (336)

The Door of Opportunity for the Designer of Metal Parts

Bulletin No. 3 sets forth much valuable data on Aluminum Bronze, stronger-than-steel die castings. Composition and characteristics described in detail. Photomicrographs, illustrations. Aurora Metal Co., Inc., 614 West Park Avenue, Aurora, Ill. (337)

The Moly Matrix

Interesting little leaflet—the first of a series—giving metallurgical facts about Molybdenum and containing information to familiarize you with the irons and steels that are made possible by the use of this "most potent alloy," which will serve to produce a better product—withstand more abuse—and last longer. Climax Molybdenum Co., 295 Madison Ave., New York, N. Y. (338)

Duro Brick and Duro Cement

Leaflet setting forth the uses and application of these products together with general data on the subject. Electro-Chemical Supply and Engineering Co., Paoli, Pa. (339)

P.B. Sillimanite Air-Setting Cement

Booklet containing data on this air-setting cement for furnace construction and repairs. The Chas. Taylor Sons Co., Cincinnati, Ohio. (340)

Two New Metallographic Polishing Machines

Leaflet illustrating and describing portable and floor models of polishing machines. Eberbach & Son Co., Inc., Ann Arbor, Mich. (341)

An Achievement in the Pyrometer Field

Leaflet illustrating and describing features of Model 28, the super pyrometer recorder with the exclusive feature of being the only pyrometer recorder with records visible while being made. Thwing Instrument Co., 3339 Lancaster Ave., Philadelphia, Pa. (342)

Riverside Free-Cutting

Pamphlet containing data on free cutting phosphor bronze, nickel silver and special bronze alloys which have been specially developed for high speed, automatic milling, threading and machining. Microstructure of free-cutting phosphor bronze and nickel silver. The Riverside Metal Co., Riverside (Burlington County) New Jersey. (343)

Elfur Electric Furnace Iron Alloys

Bulletin setting forth data on Ni-Resist corrosion and heat resistant alloy particularly suited for locomotive wearing parts, Diesel engine parts, automotive wearing parts, metal working industry, etc. Typical specification. Illustrations, mechanical properties, table showing relative corrosion resistance of cast iron and Ni-Resist. Cramp Brass and Iron Foundries Co., Paschall Station, Philadelphia, Pa. (344)

Kramer Alloys

Much useful information is contained in three little leaflets as follows: "Kramer Nickel Silver Ingot," "Improve your Castings with Kramer Alloys," containing information about Brass and bronze ingots, aluminum ingots and alloys and special intermediate fluxing alloys. Also "Kramer Manganese Bronze Ingots." H. Kramer & Co., 21st and Loomis Sts., Chicago, Ill. (345)

A C F Berwick Electric Metal Heaters

Leaflet illustrating and describing this type of heaters equipped with temperature controlling devices. American Car & Foundry Co., 30 Church St., New York, N. Y. (346)

The New K & S Pyrometer

Leaflet illustrating and describing this innovation in pyrometry the four outstanding features of which are simplest to use, most compact, accurate and lowest cost. The Industrial Pyrometer Co., P. O. Box 175, Painesville, Ohio. (347)

Pire Plastic Insulating Refractory

Leaflet setting forth data on this entirely new product. Tables showing time saved and low heat storage of PIRE. Installation data. Chicago Fire Brick Co., 1461 Elston Avenue, Chicago, Ill. (348)

Precious Metal Cyanides

Leaflet on the subject of cyanides for gold and silver plating. Basic solution formulas, solution analysis. The R. & H. Chemicals Dept., E. I. duPont de Nemours & Co., Inc., Wilmington, Dela. (349)

Rockwell Belt-Conveyor Type Electric Furnace

Leaflet No. 345 gives data on the subject of this furnace. Standard sizes and capacities table. Illustrated. W. S. Rockwell Co., 50 Church Street, New York. (350)

Facts About Jewell Alloy Metal

Leaflet containing data on this alloy metal, what it is, where it applies and other outstanding advantages. Outstanding accomplishments of Jewell alloy metal, comparative physical properties of common castings table, comparative machining test table. Jewell Steel & Malleable Co., 373 Hertel Ave., Buffalo, N. Y. (351)

A. P. Green's Plastic Quik-Pach

Leaflet illustrating and describing fire brick in plastic form for furnace repairs that is economical and easy to use. A. P. Green Fire Brick Co., Mexico, Mo. (352)

Soffel's Cupola and Ladle Flux in Cupola Practice

Booklet published in the interest of the iron founder on the subject indicated. Much valuable information. Pittsburgh Metals Purifying Corp., P. O. Box 31, N. S. Pittsburgh, Pa. (353)

Seymour Phosphor Bronze

Leaflet on the subject of the metal that writes its history with the pen of achievement. The outstanding characteristics of this alloy are:

(1) its resistance to corrosion, particularly from salt water; (2) the negligible effect of even considerable rise of temperature upon its mechanical properties; (3) its refusal to emit a spark when struck; (4) its high resistance to friction; (5) its resistance to fatigue in spring service; (6) its high resiliency. The Seymour Mfg. Co., Seymour, Conn. (354)

Manufacturing Costs Reduced with Nickel Tin and Chrome Tin

Attractive leaflet setting forth the many important uses with two factors in common—low cost and fine appearance—of nickel tin and chrome tin. American Nickeloid Co., Peru, Ill. (355)

Cyanides and Salts

Manual for heat treating steels with duPont Cyanides and salts for the metallurgist and steel treater. Information given in this manual covers the procedure to be followed for case hardening, reheating, nitriding and mottling steels with duPont sodium cyanide; it also describes the procedure for coloring, tempering and drawing steels with duPont heat treating salts. This manual has been made as complete as possible but of necessity is general in character. E. I. du Pont de Nemours & Co., Wilmington, Del. (356)

Liquid Baths for Heat Treating

Handbook which discusses the operation of salt baths for tempering, normalizing, annealing and hardening of steel. Shows several different furnace designs and gives many pointers on the efficient operation of salt bath furnaces. E. F. Houghton & Co., 3rd & Somerset Streets, Philadelphia, Pa. (357)

Ing-O-Clad Stainless Clad Steel

Manual of welding and fabricating procedures for Ing-O-Clad Stainless Clad Steel. Illustrates a few of the uses of the material. Ingersoll Steel & Disc Co. (a division of the Borg-Warner Corp.), 310 South Michigan Avenue, Chicago, Ill. (358)

METALS & ALLOYS, 330 West 42nd St., New York, N. Y.

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